Volume 26 JUNE, 1942 Number 6

BULLETIN

of the

American Association *of* Petroleum Geologists

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BULLETIN

of the

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

OFFICE OF PUBLICATION, 708 WRIGHT BUILDING, TULSA, OKLAHOMA

THE BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS is published by the Association on the 15th of each month. Editorial and publication office, 708 Wright Building, Tulsa, Oklahoma, Post Office Box 979.

THE SUBSCRIPTION PRICE to non-members of the Association is $15.00 per year (separate numbers, $1.50) prepaid to addresses in the United States. For addresses outside the United States, an additional charge of $0.40 is made on each subscription to cover extra wrapping and handling.

British agent: Thomas Murby & Co., 1 Fleet Lane, Ludgate Circus, London, E. C. 4.

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BOX 979
TULSA, OKLAHOMA

Entered as second-class matter at the Post Office at Tulsa, Oklahoma, and at the Post Office at Menasha, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized March 9, 1913.

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Volume 26 Number 6

BULLETIN
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

JUNE, 1942

WILDCAT DRILLING IN 1941 WITH COMMENTS ON DISCOVERY RATE[1]

FREDERIC H. LAHEE[2]
Dallas, Texas

ABSTRACT

The total number of wildcats drilled in 1941, in the states covered by this report, was 3,264, and the footage drilled was 11,615,085, as contrasted with 3,038 holes and 10,144,870 feet, respectively, in 1940. The average depth of hole increased from 3,339 feet to 3,559 feet for all states covered, and from 4,209 feet to 4,372 feet in the southern states.

This résumé on wildcatting is followed by a study of discovery rate in the eleven states of Arkansas, California, Illinois, Indiana, Kansas, Louisiana, Michigan, Mississippi, New Mexico, Oklahoma, and Texas. Discovery rate is measured by the relations between wildcatting and the discovery of new reserves during the last half decade. Except for a slight rise, in 1941, in the curves expressing rate of discovery, there has been a decline since 1937. The facts are a challenge to the industry not only to expand exploration, but also to promote research which may in any manner improve or revise our present methods of looking for oil.

This paper reviews data on wildcat drilling for the seventh consecutive year.[3] The states from which information was available are indicated in Figure 1.

We have continued to use the definition of a wildcat as a hole drilled completely outside the known boundaries of pools already developed, and far enough from producing areas to be essentially a test of new possibilities. Generally speaking, such a hole would be at least 2 or 3 miles from production; but, where subsurface conditions

[1] The writer acknowledges with thanks the kind assistance and coöperation of the following gentlemen in compiling data for this summary: A. P. Allison, L. J. Bateman, A. H. Bell, K. E. Born, N. Burnett, D. H. Cardwell, C. H. Coldwell, R. J. Cullen, M. H. Funk, G. C. Gester, George E. Heap, E. A. Koester, C. S. Lavington, G. D. Lindberg, A. M. Lloyd, R. W. Mallory, Graham B. Moody, D. J. Munroe, G. W. Myers, Jack Parker, Howard C. Pew, C. H. Row, G. C. Sleight, L. C. Smith, and E. B. Wilson.

Manuscript received, April 9, 1942. Presented before the Association at Denver, April 22–24, 1942.

[2] Chief geologist, Sun Oil Company.

[3] See this *Bulletin*, Vol. 21, pp. 1079–82; Vol. 22, pp. 645–48, 1231–35, 1236; Vol. 23, pp. 789–94; Vol. 24, pp. 953–58; and Vol. 25, pp. 997–1003, 1938, 1939.

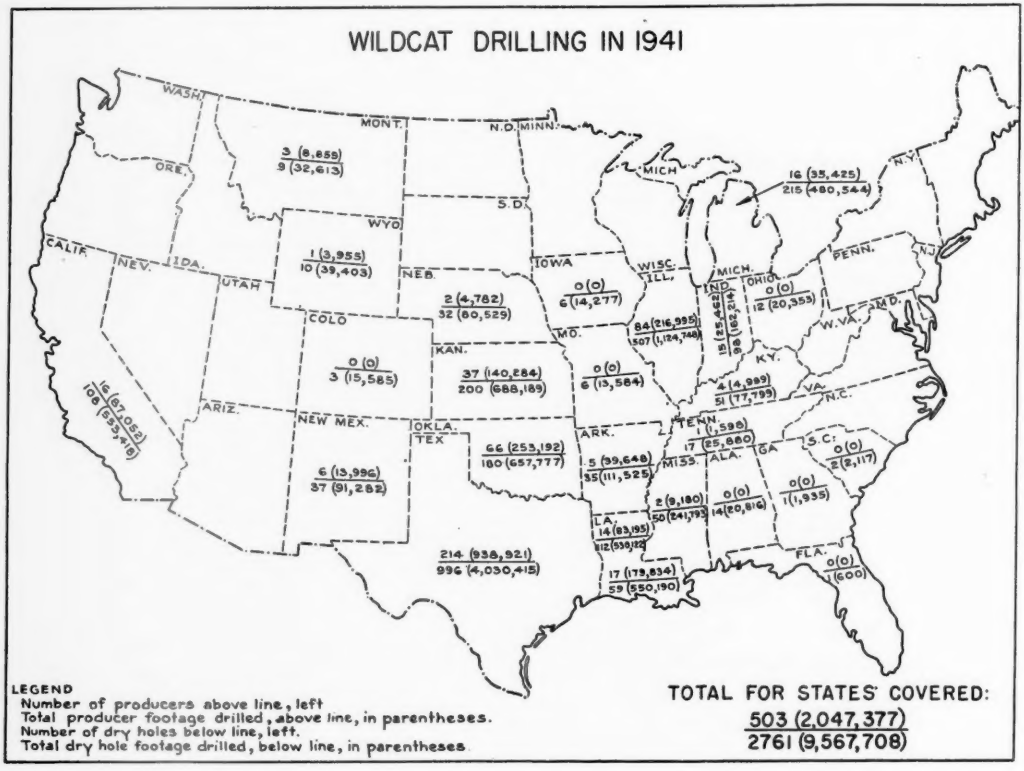
WILDCAT DRILLING IN 1941
WASH.
ORE.
CALIF.
NEV.
IDA.
MONT.
WYO.
UTAH
ARIZ.
COLO.
NEW MEX.
N.D.
S.D.
NEB.
KAN.
OKLA.
TEX.
MINN.
IOWA
MO.
ARK.
LA.
WISC.
ILL.
MICH.
IND.
OHIO
KY.
TENN.
MISS.
ALA.
GA.
FLA.
S.C.
N.C.
VA.
W.VA.
MD.
PENN.
N.Y.
N.J.
3 (8,859)
9 (32,613)
1 (3,955)
10 (39,403)
2 (4,782)
32 (80,529)
0 (0)
3 (15,585)
16 (87,052)
108 (533,918)
6 (13,996)
37 (91,282)
37 (140,284)
200 (688,189)
66 (253,192)
180 (657,777)
214 (938,921)
996 (4,030,415)
0 (0)
6 (14,277)
0 (0)
6 (13,584)
5 (39,648)
35 (111,525)
14 (83,195)
112 (530,122)
17 (179,834)
59 (550,190)
84 (216,995)
1307 (1,124,748)
15 (25,462)
98 (162,214)
2 (9,180)
50 (241,793)
1 (1,598)
17 (25,880)
0 (0)
14 (20,816)
4 (4,989)
51 (17,799)
0 (0)
12 (20,353)
16 (35,425)
215 (480,544)
0 (0)
2 (2,117)
0 (0)
1 (1,935)
0 (0)
1 (600)
LEGEND
Number of producers above line, left
Total producer footage drilled, above line, in parentheses.
Number of dry holes below line, left.
Total dry hole footage drilled, below line, in parentheses
TOTAL FOR STATES COVERED:
503 (2,047,377)
2761 (9,567,708)

FIG. 1

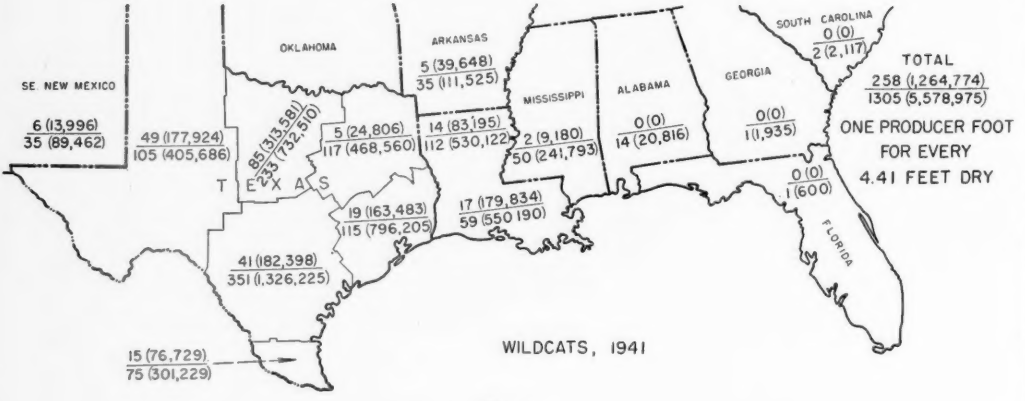
SE. NEW MEXICO
6 (13,996)
35 (89,462)
OKLAHOMA
49 (177,924)
105 (405,686)
85 (313,581)
233 (732,510)
TEXAS
ARKANSAS
5 (39,648)
35 (111,525)
5 (24,806)
117 (468,560)
14 (83,195)
112 (530,122)
19 (163,483)
115 (796,205)
17 (179,834)
59 (550,190)
41 (182,398)
351 (1,326,225)
15 (76,729)
75 (301,229)
MISSISSIPPI
2 (9,180)
50 (241,793)
ALABAMA
0 (0)
14 (20,816)
GEORGIA
0 (0)
1 (1,935)
SOUTH CAROLINA
0 (0)
2 (2,117)
0 (0)
1 (600)
FLORIDA
WILDCATS, 1941
TOTAL
258 (1,264,774)
1305 (5,578,975)
ONE PRODUCER FOOT
FOR EVERY
4.41 FEET DRY

FIG. 2

may change within short distances, as in the case of lensing sands and salt-dome structures, and where, consequently, predictions based on the known may turn out to be greatly in error, a test hole may be regarded as a wildcat even if it is only $\frac{1}{2}$ or $\frac{3}{4}$ mile from production or from an abandoned dry hole. It is important to note that this does not make *distance* from a pool the sole factor in the definition; nor should it be. Often a hole to be drilled within less than a mile from production is just as much a wildcat, is just as much a financial risk, and should receive just as much encouragement in the search for new reserves, as a hole two or three miles from production. In every case the degree of uncertainty of the geological conditions should be taken into consideration.

In compiling the data, questions have arisen as to just how to classify footage drilled in certain wells which are strictly neither dry holes nor producers from top to bottom. For instance, within the boundaries of a pool a hole may be drilled below the lowest pay zone in search of some unknown new "pay." In the sense that it is exploring for deeper untested possibilities, its footage drilled below the lowest known "pay" is wildcat. It might be called a semi-wildcat. If it discovered oil or gas in a deeper formation this extra footage might be listed as semi-wildcat discovery footage; and if, on the other hand, it failed to find a deeper "pay," the depth drilled below the lowest producing formation would then be termed semi-wildcat dry footage. For the most part this kind of semi-wildcat footage has been omitted from our statistics. It comprises only a small percentage of the whole.

A somewhat similar case is that of a wildcat well drilled through one or more prospective pay zones to a considerably greater depth and then plugged back to completion as a producer. However, in a hole of this kind, since the total depth would be charged against the cost of the completed producer, we have listed this total depth in the column for producers.

A further question was raised this year as to whether actual footage drilled within the calendar year should be the basis of footage drilled or whether, as in past reports, the total footage of all the holes actually completed or abandoned within the calendar year should be used. We have continued the latter course, first, in order that this year's figures may be more properly comparable with the figures in the earlier reports; second, because the former method requires more detailed analysis on the part of those furnishing the statistics; and third, because we are as much concerned with individual holes, as with footage in these holes, and the former method would involve considerable repetition in the *number* of holes wherever the holes were started in one year and finished in a succeeding year.

TABLE I

NUMBER OF OIL WELLS, GAS WELLS, AND DRY HOLES DRILLED AS WILDCATS IN 1941

States	Oil Discovery		Gas Discovery*		Dry		Total Number of Holes	Total Footage Drilled	Average Depth of Hole in Feet†
	Number of Holes	Footage Drilled	Number of Holes	Footage Drilled	Number of Holes	Footage Drilled			
Alabama					14	20,816	14	20,816	
Arkansas	4	30,734	1	8,914	35	111,525	40	151,173	3,779
California	13	74,611	3	12,441	108	553,418	124	640,470	5,165
Colorado					3	15,585	3	15,585	
Florida					1	600	1	600	
Georgia					1	1,935	1	1,935	
Illinois	83	214,340	1	2,655	507	1,124,748	591	1,341,743	2,270
Indiana	13	23,930	2	1,532	98	162,214	113	187,676	1,661
Iowa					6	14,277	6	14,277	
Kansas	33	123,831	4	16,453	200	688,189	237	828,473	3,494
West Kentucky	4	4,999			51	77,799	55	82,798	1,505
Louisiana	18	175,927	13	87,102	171	1,080,312	202	1,343,341	6,650
Michigan	8	13,407	8	22,018	215	480,544	231	515,969	2,234
Mississippi	2	9,180			50	241,793	52	250,973	4,826
Missouri					6	13,584	6	13,584	
Montana	1	2,065	2	6,794	9	32,613	12	41,472	
Nebraska	2	4,782			32	80,529	34	85,311	2,509
New Mexico	5	11,126	1	2,870	37	91,282	43	105,278	2,406
Ohio, N.W.					12	20,353	12	20,353	
Oklahoma	54	209,671	12	43,521	180	657,777	246	910,969	3,703
South Carolina					2	2,117	2	2,117	
Tennessee			1	1,598	17	25,880	18	27,478	
Texas	176	731,678	38	207,243	996	4,030,415	1,210	4,969,336	4,106
Wyoming			1	3,955	10	39,403	11	43,358	
Totals	416	1,630,281	87	417,096	2,761	9,567,708	3,264	11,615,085	3,559

* Gas and distillate wells, of which there were 27, are included in this column.
† Averages have been recorded here only for states where more than 25 holes were drilled in 1941.

On the maps (Figs. 1 and 2), numbers in parentheses indicate total footage drilled; figures preceding parentheses indicate the number of holes drilled; figures above the cross line are for producing wells, that is, oil, oil and gas, distillate and gas, and gas; and figures below the cross line are for dry holes.

In the states covered in this review, as shown in Figure 1, and listed in Table I, during 1941 a total of 11,615,085 feet was drilled in 3,264 holes, divided as follows.

503 producers.....2,047,377 feet
2,761 dry holes.....9,567,708 feet

This means that 15.41 per cent of the holes drilled, and 17.62 per cent of the footage drilled, was successful in 1941. One producer foot was drilled for every 4.66 feet of dry hole. One discovery well was drilled for every 5.48 dry holes. The average depth of hole was 3,559 feet.

In the southern states district (Fig. 2), in 1941, a total of 6,843,749 feet was drilled in 1,563 holes, divided as follows.

258 producers.....1,264,774 feet
1,305 dry holes.....5,578,975 feet

In this area, then, 16.51 per cent of the holes drilled, and 18.48 per cent of the footage drilled, was successful. One producer foot was drilled for every 4.41 feet of dry hole. One discovery well was drilled for every 5 dry holes. The average depth of hole was 4,372 feet. For comparison with statistics for this same area in 1938, 1939, and 1940, see Table II.

Selection of the location for a wildcat well may be based on geology (surface geology, subsurface geology, trend along known structural or stratigraphic conditions, local or regional, or shallow exploratory drilling); or it may be based on geophysics (exploration by seismograph, torsion balance, gravity meter, magnetometer, *et cetera*); or it may be based on some non-technical suggestion or requirement, such as "creekology," "hunch," "doodlebug," promotion, lease obligation, reported showing of oil or gas in holes previously drilled, *et cetera*. In many cases the reason for choosing the location can not be ascertained.

In Table III are listed the reasons for drilling the wildcats in 1941 using the best information available from men familiar with such statistics, each in his own state or district. According to these figures, 471 wildcats drilled on technical advice (geology and (or) geophysics) were successful (oil or gas), and 1,928 were dry; 30 holes located for non-technical reasons were producers, and 771 were dry; 2 producers and 62 dry holes were located for reasons unknown. These figures show that 19.5 per cent of the holes drilled on technical advice were pro-

TABLE II

COMPARATIVE STATISTICS FOR ALL STATES SHOWN IN FIGURE 2

	Producers Drilled				*Dry Holes Drilled*				*Total Number Wildcats Drilled*	*Average Depth of Hole (Feet)*	*Number of Dry-Hole Feet Drilled for Each Producer Foot*
	Holes		*Footage*		*Holes*		*Footage*				
	Number	*Per Cent*	*Feet*	*Per Cent*	*Number*	*Per Cent*	*Feet*	*Per Cent*			
1938	200	13.6	984,262	17.4	1,271	86.4	4,667,402	82.6	1,471	3,842	4.74
1939	161	12.6	779,345	14.8	1,113	87.4	4,501,669	85.2	1,274	4,145	5.90
1940	187	12.8	919,506	14.9*	1,279	87.2	5,251,273*	85.1*	1,466	4,209*	5.71*
1941	258	16.5	1,264,774	18.4	1,305	83.5	5,578,975	81.6	1,563	4,372	4.41

* See *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, p. 1938, where corrections are mentioned for these figures as they appeared in Table II, p. 1001, of the same volume.

TABLE III

BASIS FOR LOCATING WILDCATS DRILLED IN 1941

State	*Geology*		*Geophysics**		*Geology and Geophysics*		*Sundry Non-Technical*		*Unknown*		*Totals*	
	Prod.	*Dry*	*Prod.*	*Dry*	*Prod.*	*Dry*	*Prod.*	*Dry*	*Prod.*	*Dry*	*Prod.*	*Dry*
Alabama		3						11				14
Arkansas		21	5	8				6			5	35
California	10	59	6	5		20		19		5	16	108
Colorado		1		1						1		3
Florida								1				1
Georgia								1				1
Illinois	56	240	28	63		6		173		25	84	507
Indiana	13	69		5	2	6		16		2	15	98
Iowa		4		1				1				6
Kansas	22	81	8	24	1	11	6	84			37	200
West Kentucky	4	35		2				14			4	51
Louisiana	8	59	22	87	1	2		22		1	31	171
Michigan	9	107					7	108			16	215
Mississippi		9	1	12	1	8		20		1	2	50
Missouri		3		2				1				6
Montana	2	2				2		1	1	4	3	9
Nebraska	2	7		6				19			2	32
New Mexico	4	20		2	1	3	1	11		1	6	37
Ohio, Northwest		6						5		1		12
Oklahoma	30	89	30	44		2	6	45			66	180
South Carolina								2				2
Tennessee		10		2			1	5			1	17
Texas	140	546	43	173	22	51	9	206		20	214	996
Wyoming		9							1	1	1	10
Totals	300	1,380	143	437	28	111	30	771	2	62	503	2,761

* Including geochemistry.

ducers as contrasted with 3.7 per cent successful in the case of the holes located without technical advice. Therefore, in 1941 locations based on technical recommendations were more than 5 times as successful as those drilled without such advice. In the southern states (Fig. 2), 3.5 per cent of the wildcats, located without technical advice, were producers, whereas 19.8 per cent of the holes located on technical advice were producers.

Comparing last year's figures[4] with figures for 1941, we note the following conspicuous changes.

1. There was a considerable increase in wildcat drilling in California (up from 104 holes in 1940 to 124 holes in 1941); in Texas (up from 1,091 holes in 1940 to 1,210 holes in 1941); in Kansas (up from 145 holes in 1940 to 237 holes in 1941); in Louisiana (up from 174 holes in 1940 to 202 holes in 1941); and in Illinois (up from 523 holes in 1940 to 591 holes in 1941).

2. There was a conspicuous drop in wildcatting in Michigan (down from 354 holes in 1940 to 231 holes in 1941); and in Mississippi (down from 109 holes in 1940 to 52 holes in 1941).

Footage figures vary roughly in the same proportions both under paragraph 1 and paragraph 2.

3. The number of successful holes (discovery wells) out of the total number of wildcats drilled on technical advice rose from 15.6 per cent in 1940 to 19.5 per cent in 1941; and, on the contrary, successful holes drilled without technical advice decreased from 4.2 per cent to 3.7 per cent of the total number of wildcats drilled without technical advice.

4. Last year and in the preceding year[5] we called attention to the fact that, whereas in 1937 there were 3 times as many discovery wildcats drilled on technical advice as there were drilled for non-technical reasons, in 1938 this factor had decreased to between 2.2 and 3.2, and in 1939 it had further decreased to between 1.5 and 2.2. In 1940, this factor jumped to 3.7, and in 1941 it increased further to more than 5. There has been a growing tendency to seek technical advice before selecting a wildcat location, and especially is this true where deep drilling is contemplated.

Wildcatting is the industry's method of seeking new oil. From the experience of 1941 we might say that one wildcat in a little better than six is successful—and this takes into consideration not only all oil

[4] F. H. Lahee, "Wildcat Drilling in 1940," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 6 (June, 1941), pp. 997–1003; and note corrections mentioned, *ibid.*, pp. 1938, 1939, in the October number.

[5] F. H. Lahee, "Wildcat Drilling in 1939," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, p. 958; and "Wildcat Drilling in 1940," *ibid.*, Vol. 25, p. 1003.

• Including geochemistry.

discovery wells but also those which discover gas or distillate. After a successful wildcat has been completed as a producer, other wells are subsequently drilled and these gradually outline the limits of the pool.

Where development is slow, or the pool is large, this process of outlining the pool may require several years. There is always a lag. After the first well has been completed, or perhaps after several wells have been completed, an estimate can be made of the quantity of oil present in the drilled area, and this area is taken as essentially proved. If the pay sand is thick and uniform and fairly even in its permeability, a larger acreage may be regarded as "proved" by the drilling than in the case where the sand is thin, irregular in permeability, and likely to pinch out. If the form and dimensions of the structure, or "trap," are pretty definitely known, an early estimate may be attempted of the quantity of oil present in the whole reservoir, including its undrilled parts. This is an attempt to guess at the ultimate total reserve rather than at the "proved" part of this ultimate total reserve.

Both of these methods of estimating reserves[6] are justified. Each has its definite uses, but *the two should not be confused.* Where estimates are made of *proved* reserves, additions and revisions are periodically necessary, and eventually, after a pool has been completely drilled, the original estimate of the proved reserve plus the subsequent additions and revisions may come somewhere near the total ultimate reserve as estimated near the beginning of development of the pool. However, it is evident that such an early estimate, based on scanty data, is likely to be in error, and the percentage error is likely to be much greater than the percentage error in an estimate of *proved* reserves, made at any given time.

Rate of discovery is the rate at which new oil reserves are discovered, but a graphic picture of this rate may vary considerably according to whether we regard as the oil discovered in any given year the quantity of new oil *proved* by drilling in that year, or the quantity of total new oil estimated to fill the reservoir, or reservoirs, discovered in that year. Although in overlapping periods of several years each, the pictures might be somewhat similar, in single year intervals there may be wide discrepancies between the rate of discovery calculated in the two ways, due to lag in development, size of pool, *et cetera.*

The suggestion has been offered that a more correct picture of the rate of discovery could be obtained by annually relegating back to the year of discovery the reserves subsequently uncovered each year by drilling; but this would not only involve an enormous amount of

[6] See F. H. Lahee, "This Matter of Estimating Oil Reserves," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25 (1941), pp. 164–66.

TABLE IV

Estimated Proved Reserves in U. S. at Beginning of Year* (Barrels)	Wildcats Drilled during Year Indicated* Number	Footage
1937 13,063,000,000	2,224	8,387,615
1938 15,507,268,000	2,638	8,860,484
1939 17,348,146,000	2,589	8,624,602
1940 18,483,012,000	3,038	10,144,870
1941 19,024,515,000	3,264	11,615,085
1942 19,589,296,000		

* These figures for reserves include the entire United States, but for wildcats they include all states regarded as prospective for oil except New York, Pennsylvania, Eastern Ohio, West Virginia, and Eastern Kentucky.

The above figures on reserves were taken from *Facts and Figures*, 7th ed., p. 74, published by the American Petroleum Institute, 1941. Figures for reserves as of January 1, 1942, were taken from a recent press release from the American Petroleum Institute. The data for wildcats were taken from the articles printed in the A.A.P.G. *Bulletin*, and listed in footnote 3.

TABLE V

STATISTICS ON WILDCATS IN AREA UNDER CONSIDERATION*

	Located on Technical Basis				Non-Technical Location				Unknown Basis for Location				Total				Grand Totals	Total Footage		Number of Feet in Dry Holes Drilled Per Foot in Producing Wildcats
	Producers		Dry Holes		Producers		Dry Holes		Producers		Dry Holes		Producers		Dry Holes					
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Wildcats	Producers	Dry Wildcats	
1937	214	16.05	1,119	83.95	17	5.80	276	94.20	48	9.21	473	90.79	279	12.99	1,868	87.01	2,147	1,188,366	7,002,875	5.89
1938	283	17.93	1,295	82.07	43	7.61	522	92.39	17	4.67	347	95.33	343	13.68	2,164	86.32	2,507	1,482,889	7,119,867	4.80
1939	216	13.33	1,404	86.67	43	6.15	656	93.85	10	4.85	196	95.15	269	10.65	2,256	89.35	2,525	1,107,395	7,344,424	6.63
1940	309	15.69	1,660	84.31	35	4.57	731	95.43	11	8.09	125	91.91	355	12.37	2,516	87.63	2,871	1,397,496	8,416,015	6.02
1941	463	20.17	1,832	79.83	29	3.92	710	96.08	0	0	55	100.00	492	15.92	2,597	84.08	3,089	2,023,184	9,222,217	4.55
Total for '37–'41	1,485	16.88	7,310	83.12	167	5.45	2,895	94.55	86	6.70	1,196	93.30	1,738	13.22	11,401	86.78	13,139	7,199,330	39,105,398	5.43

* This area includes California, New Mexico, Texas, Oklahoma, Kansas, Arkansas, Louisiana, Mississippi, Illinois, Indiana, and Michigan. Full statistics were not available on the other producing states.

TABLE VI

STATISTICS ON PROVED RESERVES IN AREA OF ELEVEN STATES*

	1937	1938	1939	1940	1941	1942
A. Proved reserves as of Jan. 1 of year indicated	12,241,885,000	14,664,035,000	16,630,452,000	17,723,393,000	18,226,542,000	18,816,785,000
B. Net change in proved reserves since Jan. 1 of previous year		+2,422,150,000	+1,966,417,000	+1,092,941,000	+503,149,000	+590,243,000
C. New proved reserves discovered during year indicated	896,692,000	805,293,000	337,989,000	280,882,000	423,551,000	
D. New reserves added through extensions and revisions of old fields during year indicated	2,739,254,000	2,313,356,000	1,955,507,000	1,505,816,000	1,496,610,000	
E. Total new proved reserves added (C+D)	3,635,946,000	3,118,649,000	2,293,496,000	1,786,698,000	1,920,161,000	
F. Production during year indicated	1,213,796,000	1,152,231,000	1,200,555,000	1,283,490,000	1,329,918,000	
G. Years of remaining proved supply on Jan. 1 of year indicated, based on production of preceding year	11.74 Yrs.†	12.08 Yrs.	14.43 Yrs.	14.76 Yrs.	14.20 Yrs.	14.15 Yrs.
H. Newly discovered reserves (C) per wildcat hole drilled in year indicated	417,647	321,217	133,857	97,834	137,115	
I. Newly discovered reserves (C) per foot of wildcat hole drilled in year indicated	109.4	93.6	39.9	28.6	37.7	
J. New proved reserves (E) per wildcat hole drilled in year indicated	1,693,500	1,243,976	908,315	622,326	621,612	
K. New proved reserves (E) per foot of wildcat hole drilled in year indicated	443.88	362.52	271.36	182.07	170.75	

* This area includes Arkansas, California, Illinois, Indiana, Kansas, Louisiana, Michigan, Mississippi, New Mexico, Oklahoma, and Texas. All figures are in barrels, except under item G.

† Production in 1936: 1,042,464,000 barrels.

work, but also, in the end, as far as we can see it, there would be little gained. For of what particular value would it be for us to know, *merely as a means of gauging discovery rate*, that a reserve of over 4 billion barrels of oil was found in 1930 in the East Texas field? Of more significance—again, only as applied to the study of discovery rate—is the quantity of new oil made available each year as drilling of this field progressed. We repeat that, while there *are* real and important reasons for making early estimates of total ultimate reserves in a pool, we believe that the soundest method of measuring rate of discovery must be based on new reserves as proved by drilling.

With this preamble behind us, let us examine statistics on proved reserves and wildcatting for the last 5 years.[7] Since complete data are not available for all states, we shall limit the succeeding discussion to the following 11 states as a group: Arkansas, California, Illinois, Indiana, Kansas, Louisiana, Michigan, Mississippi, New Mexico, Oklahoma, and Texas. As may be seen by comparing certain items in Tables V and VI with the data in Table IV, these eleven states together include a large proportion both of the proved oil reserves and of the wildcatting activities of the country.

Table IV requires no special comment.

Table V lists statistics on wildcat drilling in the area of the eleven states mentioned. These wildcats have been classified according to the reason for locating them where they were drilled, and also according to whether they were completed as producers of oil or gas, or were abandoned as dry holes. In the 5-year period, 16.88 per cent of the wildcats located on a technical basis (geology or geophysics or both) were producers; 5.45 per cent of the wildcats located on the basis of various non-technical reasons were producers; that is, where the reason for the location was known, in collecting the statistics, those wildcats located on a technical basis were more than three times as successful as those located without technical advice.

During this 5-year period, 5.43 feet of dry holes were drilled for every foot drilled in the producer wildcats.

There are several ways of estimating the degree of success of wildcat drilling. We have called successful those wildcat holes (and the footage drilled in these holes), which were completed as commercial producers. However, we can consider wildcatting in relation to oil reserves discovered by this class of drilling. In Table VI, under *A*, are recorded the proved reserves as of January 1 in each of the indicated years, and for the eleven-states area under discussion. Under *B*

[7] Information on proved reserves is taken from the *American Petroleum Institute Quarterly*, in April of each year from 1937 to 1942, inclusive. Information on wildcatting is from papers listed in footnote 3, p. 969.

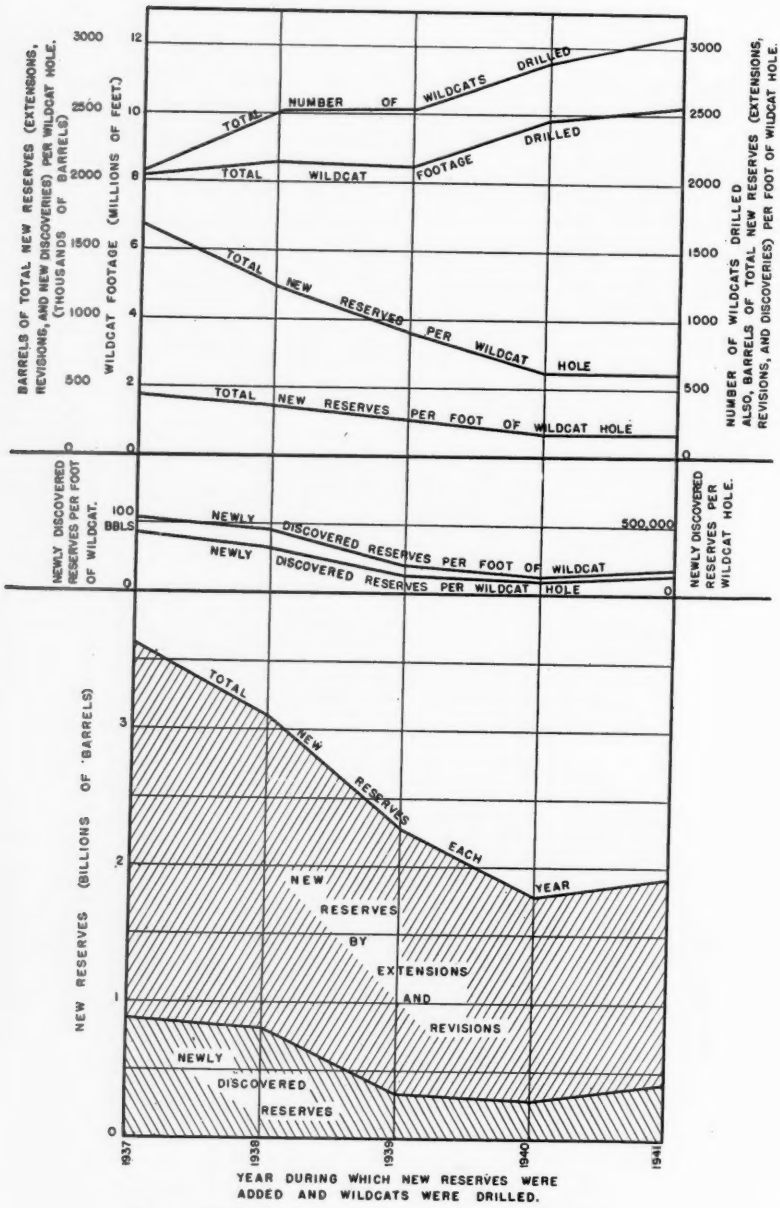

FIG. 3.—Wildcatting and discovery of reserves, 1937–1941.

is shown, for each January first, the net change in estimated proved reserves since the preceding January first, allowing for production during that twelve-months period. Under *C* are the new reserves which are directly attributable to wildcat discoveries made during the year. Under *D* are the revisions and additions of estimated reserves in fields already discovered in previous years, these revisions and additions having been made on the basis of new information obtained through development during the year indicated.

As we have explained, the reserves in group *D* might be assigned back to the year of discovery, but due to the present incompleteness of available statistics, this can not readily be done. Instead, we may regard both groups of new reserves (*C* and *D*) as directly and indirectly resulting from original wildcat discoveries. If, for each year, we divide the newly discovered reserves (*C*, Table VI) by the number of wildcats drilled in that year, or by the total wildcat footage drilled in that year, we shall have a measure of the degree of success of wildcatting in terms of newly discovered reserves (*H* and *I*, Table VI); and if we divide the total new reserves (discoveries plus revisions plus extensions: *E*, Table VI) by the number of wildcats drilled, or by the total wildcat footage drilled, we shall have a measure of the degree of success of wildcatting assisted by outpost drilling (*J* and *K*, Table VI). Under *H* and *I* the measure is short. Under *J* and *K*, the measure may be too large or too small. In any case, there is an unavoidable error in estimating *rate of discovery*, or degree of success in wildcatting, measured in terms of new reserves; but the figures obtainable by these methods, as here described, are a significant index. They reveal a regular drop in rate of discovery through the first 4 years with a flattening of the curve through 1941, whichever way we compare the data. (See Fig. 3.)

What is the significance of this falling rate of discovery? It can not be due to lessened activity in wildcatting, for, except for a temporary set-back in 1939, the number and average depth of wildcats has increased through the 5-year period. (See Fig. 3.) Nor can it be due to any lessened application of technical methods in exploration, for there has been a steady advance in the refinement and use of techniques. We believe it is due mainly to the growing difficulty of finding new geological traps for oil. The more conspicuous and easily mapped structures have long ago been located and drilled. Also, drilling has tested most of the shallower prospects on these structures. Remaining undiscovered reserves are largely either (1) in regions not yet explored; or (2) they are in reservoirs deeper than those reached on already exploited structures and often unconformably related to the strata

that contain the known reserves; or (3) they are in reservoirs of the stratigraphic pinch-out type, which can seldom be located by surface observations.

To look for oil under the first of these conditions will need increased activity in exploration and in drilling in areas which do not now produce oil, but which are rated as having some prospects.[8] To look for oil under the second of the conditions just mentioned will require deep wildcatting and also deeper drilling on known structures or within the confines of known pools. To look for oil under the third condition will require the drilling of many holes, some of which may be purely informational, but all of which will help in locating the positions and trends of subsurface stratigraphic pinch-outs. If we are to maintain a satisfactory discovery rate, as applied to new reserves, we must become more vigorous than heretofore in our wildcatting campaign. We must show a strongly rising curve in the annual number, and in the annual average depth, of wildcat operations. The picture, as we see it to-day, is a grave challenge to the industry as a whole to expand its program of exploration and to encourage any branch of research that may give us new or better methods of looking for oil.

[8] See "Possible Future Oil Provinces of the United States and Canada." Edited by A. I. Levorsen. *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25 (1941), pp. 1433–1586.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 983–990, 1 FIG.

REVIEW OF DEVELOPMENTS IN 1941, GULF COAST OF UPPER TEXAS AND LOUISIANA[1]

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ABSTRACT

More refined methods of oil exploration have resulted in a slight increase in the discovery rate on the Texas Gulf Coast for 1941 but the generally second-grade type of individual pool that has resulted from exploratory activity during the past few years, still characterizes the discovery column. Coastal Louisiana has had a successful year, with 17 new productive areas but there is no one of these that seems at this time to compare with some of the outstanding discoveries of recent years.

Activity along the Eocene Wilcox trend has been rather successful in Texas for 1941 but has failed to result in a new discovery in Louisiana. Louisiana, however, has made impressive additions to the reserves of previously discovered fields by extension and through the opening of new producing sands.

INTRODUCTION

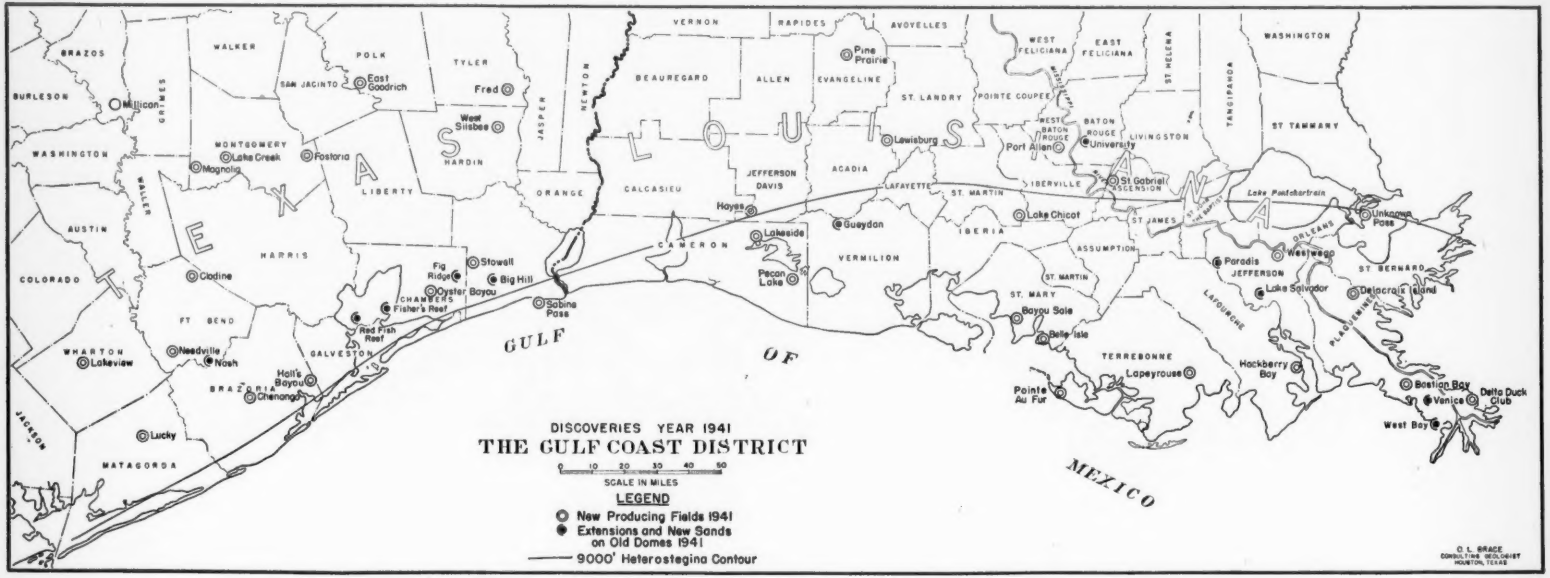
The unfavorable trend in the upper Texas coastal discovery rate that set in about the year 1937 has continued through 1941. This unfavorable trend has not been so much a matter of numbers of new discoveries, as of quality of the individual discovery. For example, there were 10 new areas brought into production in 1939 and 12 in 1940. This number further increased to 15 in 1941. Yet the amounts of new reserves represented by the 15 new areas of this past year are unquestionably smaller than were those of the 10 new areas for 1939.

In past reviews, it has been pointed out that there is no exact parallel between the discovery rate in the upper Texas Coast and in the Louisiana Coast, because of the lag in Louisiana development resulting from the inaccessibility until recent years of the vast swampy Mississippi Delta region. Thus, the rate of Louisiana discovery has been increasing both as to quantity and to quality of new reserve areas while Texas has been on the decline, although there are indications that Louisiana has reached its peak and may already have started on the down grade.

In 1941, discoveries for Louisiana constitute an impressive list of 17 new areas, compared with 16 for 1940. The list is made up predominantly of second-rate prospects, with two or three that hold promise of developing into major pools, and several that are destined never to justify the expenditures that were required to carry out the initial exploration.

[1] Presented by title before the Association at Denver, April 22–24, 1942. Manuscript received, February 12, 1942.

[2] Consulting geologist, 803 Second National Bank Building.


DISCOVERIES YEAR 1941
THE GULF COAST DISTRICT
SCALE IN MILES
0 10 20 30 40 50
LEGEND
New Producing Fields 1941
Extensions and New Sands on Old Domes 1941
9000' Heterostegina Contour
GULF OF MEXICO
TEXAS
LOUISIANA
BRAZOS
BURLESON
WASHINGTON
AUSTIN
COLORADO
WHARTON
MATAGORDA
JACKSON
WALKER
GRIMES
WALLER
MONTGOMERY
HARRIS
FT BEND
BRAZORIA
GALVESTON
POLK
SAN JACINTO
LIBERTY
CHAMBERS
TYLER
HARDIN
JEFFERSON
ORANGE
JASPER
NEWTON
CALCASIEU
CAMERON
VERNON
BEAUREGARD
RAPIDES
ALLEN
AVOYELLES
EVANGELINE
JEFFERSON DAVIS
ACADIA
VERMILION
WEST FELICIANA
EAST FELICIANA
ST HELENA
POINTE COUPEE
WEST BATON ROUGE
BATON ROUGE
LIVINGSTON
ST LANDRY
LAFAYETTE
ST MARTIN
IBERIA
IBERVILLE
ASSUMPTION
ST MARY
TERREBONNE
ST JAMES
ST JOHN
ST CHARLES
ORLEANS
JEFFERSON
PLAQUEMINES
LAFOURCHE
ST BERNARD
WASHINGTON
ST TAMMANY
TANGIPAHOA
Millican
East Goodrich
Fred
West Silsbee
Magnolia
Lake Creek
Fostoria
Clodine
Needville
Nosh
Lakeview
Hall's Bayou
Chenango
Lucky
Stowell
Fig Ridge
Oyster Bayou
Big Hill
Fisher's Reef
Red Fish Reef
Sabine Pass
Hayes
Lakeside
Pecan Lake
Gueydan
Lewisburg
Pine Prairie
Port Allen
University
Lake Chicot
St Gabriel
Bayou Sale
Belle Isle
Pointe Au Fur
Lapeyrouse
Hackberry Bay
Paradis
Westwego
Lake Salvador
Delacroix Island
Unknown Pass
Lake Pontchartrain
Boston Bay
Venice
Delta Duck Club
West Bay
C. L. BRACE
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HOUSTON, TEXAS

FIG. 1

UPPER COASTAL TEXAS

It has become increasingly difficult during the past few years to place an intelligent initial rating, from a reserve standpoint, on areas in which discovery wells have been completed on the upper Texas Coast. During this period, there have been many new wells which custom dictated should be classed as discoveries, but in which there was exhibited none of the characteristics that ordinarily indicate worthwhile production. The discovery list for 1940, which included 12 new areas, was regarded with rather dismal expectations in the review for that year and this pessimistic outlook has been supported by exploitation during the past year, in that no one of these new areas has developed into a reserve of major proportions.

The 1941 discoveries, which incorporate a list of 15 new areas, are now placed with few exceptions in the same unpromising category. Most of the discovery wells are not promising, either because of thin sands, erratic structural development, or unfavorable gas ratios. The outstandingly favorable features that characterize an area of the Hastings or Anahuac type are unquestionably missing in each case. Minor faulting, rather than major structural uplift, has become the dominant controlling structural factor, with a consequent reduction in area and in the amount of structural relief and the height of the column of saturation.

In the 1940 review, considerable stress was laid on the influence of new drilling and testing techniques, such as the electric log, gun perforator, and cement squeezing, on the type of discovery and it was pointed out that the steady increase in the percentage of new discovery areas, that must be classed as low grade and of questionable economic value, is the direct result of the enlarged use of these new implements and methods. The significance of this statement has been greatly broadened during 1940, since many of those wildcat producers that must be listed as discoveries might have been regarded a few years ago as not worthy of completion.

In line with earlier predictions, there has been a rapid increase in the rate of exploration along the updip Wilcox trend. This has resulted in the discovery of three new Wilcox fields, two of which seem to hold considerable promise. Also as a result of this activity, four new Cockfield productive areas were located, a result that may be regarded more or less as accidental in the search for Wilcox oil.

The Wilcox discoveries include *Lake Creek* and *Magnolia* in Montgomery County and *Fred* in Tyler County. Magnolia and Fred are one-well fields at the present date, completed in sands at 8,180 and 8,448 feet, respectively. At Magnolia, the discovery well,

Glenn McCarthy's Seyle No. 1, is a gas-distillate producer, but the amount of productive sand reported indicates that the area may represent a reserve of considerable consequence. At Fred, the Stanolind Oil and Gas Company's Parker No. 1 is making 40°-gravity oil, but little is known as to the potentialities of the new area. It is probable that accumulation occurs on the downthrown coastward side of a strike fault, which fault would lie south from, and parallel with, the fault that forms the trap at Joe's Lake.

From the standpoint of reserves, there are indications that Lake Creek may be the most important discovery of the year. The discovery well, the Superior Oil Company of California's McWhorter No. 1, was completed at 9,212–9,217 feet as a gas well with distillate that is reported to have a ratio of seven gallons per 1,000 cubic feet. A second well was drilled by the Superior to 13,300 feet, after encountering the top of the Wilcox at 8,453 feet. It is reported that this well penetrated several hundred feet of gas-distillate sand, together with an unstated amount of oil sand below the 10,000-foot level, but it was finally plugged back and completed at 9,778 feet. It must be pointed out that the Superior has released no detailed information regarding this area and, in consequence, the favorable data here cited have not been verified from that source. Structural closure probably results from strike faulting with major displacement, with the Magnolia area lying to the southwest along the same fault zone.

The Cockfield areas aforementioned include *East Goodrich*, Polk County, *Fostoria*, Montgomery County, *Clodine*, Fort Bend County, and *West Silsbee*, Hardin County. None of these has shown indication of major accumulation as yet. There are indications that faulting is a factor at both East Goodrich and Fostoria, discovered by Pan American Production Company and the Atlantic Refining Company, respectively, but saturated sand zones are thin at each place and neither looks attractive. Clodine occupies a broad irregular structure but sands have been proved erratic so far, and gas ratios are high. There is only one well at West Silsbee and the area may be an off-shoot from the Silsbee area proper.

The remaining eight discoveries are located in the deep coastal zone. Six of these are completed in Frio sand and range from *Chenango*, Brazoria County, where the discovery well is ringed with dry holes, to *Oyster Bayou*, the Sun Oil Company's discovery in Chambers County. The latter area extends along the fault zone which controls *Fig Ridge*, *Seabreeze*, and *Willow Slough*, and, with five wells completed in sand at approximately 8,250 feet, it holds promise of being a worthwhile field. The remaining Frio areas include *Halls' Bayou*, Brazoria County,

where the discovery well has been abandoned, *Needville*, Fort Bend County, a single shut-in gas well, and *Lucky*, Matagorda County. The last area was discovered by the Stanolind Oil and Gas Company in March and there are now two producers from sand at about 8,800 feet. Accumulation occurs on a low-relief structure, complicated by faulting.

The sixth Frio field is *Stowell*, Jefferson County, discovered in October by Glenn McCarthy. The one completed well appears to be on the coastward, downthrown side of a strike fault, forming a trap of a type that has been duplicated in several places in this part of the coast. Production is from thin sands, and the showing for a worthwhile field is none too promising.

Two Miocene discoveries have shown nothing to date to recommend them. *Lakeview*, Wharton County, is the discovery of W. R. Davis, completed as a small gas well at 3,400 feet. *Sabine Pass*, Jefferson County, was classed as a discovery after completion of the Hall-Jordan-British American Oil Producing Company's State No. 1 as a small oil and water well in sand at 4,982–4,992 feet. There are many interesting features about the Sabine Pass structure, despite the fact that much money has been expended without resulting in stable production. The structure is a dome with major uplift, cut by faults with displacement in excess of 500 feet. The apex, according to the present interpretation, lies in the Gulf of Mexico about 2 miles off the Jefferson County shore. Several dry holes have been drilled along the shore and one well is now being drilled near the discovery well.

EXTENSIONS AND NEW SANDS

Numerous extensions of proved areas have improved the reserve situation. Such extensions have been of marked importance at *Fig Ridge*, Chambers County, and in the two Galveston Bay fields, *Fisher's Reef* and *Red Fish Reef*.

New flank production was established at two old piercement domes. At *Big Hill*, Jefferson County, the Stanolind Oil and Gas Company found Oligocene gas-distillate production at 8,705 feet, whereas the Atlantic Refining Company opened a somewhat promising Miocene zone on the northeast flank of *Nash Dome*, Fort Bend County, at 4,294 feet.

On the inner margin of the established region of salt-dome occurrence, the Phillips Petroleum Company located a new, relatively shallow salt mass near the town of Millican in Brazos County. Drilled on the downthrown, coastal side of a well known surface fault, the test encountered cap rock at 4,890 feet and salt at 5,170 feet. It was completed in salt at 5,510 feet with no showings of oil or gas reported.

COASTAL LOUISIANA

The discovery list for coastal Louisiana is somewhat longer than the average of recent years but there appears to be no really outstanding new area that will compare with *Paradis* in 1939 or *Lake Salvador* in 1940. After 8 months of development, Lake Salvador has 10 completed wells with about 3,000 barrels of daily production, whereas 2 years of development have resulted in 19 producers at Paradis with 5,150 barrels of daily production. Each has fully justified the early favorable rating given it in these reviews.

An interesting feature regarding developments in coastal Louisiana is that no new Wilcox fields were discovered during 1941. This statement, of course, refers to the Coast and not to central Louisiana, where development of the updip Wilcox has been rather successful. It is true that activity along the downdip Wilcox trend has not been as intensive here as on the Texas side but the negative results obtained from the limited drilling have been disappointing.

The Miocene continues to be the chief source of new oil in south Louisiana, with 13 of the 17 discovery wells in 1941 completed in sands of this age. Discoveries along the inner trend of normal Oligocene production appear to have less merit than those located in the swampy delta lands adjacent to the Gulf. Along this inner trend, four new fields have been completed in sands older than Miocene. The first of these, *Hayes*, in Calcasieu Parish, has been on and off the discovery lists several times during previous years. A new well drilled by the Gulf Refining Company is making large quantities of gas and distillate from the Frio below 10,000 feet. At *Lewisburg*, northeast Acadia Parish, a new gas and distillate field in the lower Oligocene, below 10,000 feet, has an exceptionally favorable sand section. The structure is of the Tepetate type, accumulation occurring on the downthrown coastal side of a strike fault.

The discovery of flank production at *Pine Prairie*, Evangeline Parish, is of special interest. This is a piercement dome with cap rock at the surface, where intermittent exploitation has been in progress for many years. The discovery well was finished in the Cockfield sand at 8,200 feet, with large production. Since discovery, ten wells have been completed and the field seems to represent a very considerable reserve, although the producing area has so far been proved to be narrow and is confined to the east flank of the dome. At *Port Allen*, West Baton Rouge Parish, the Amerada Petroleum Corporation found *Marginulina* production at 9,600 feet, in an area about which the structural details are little known. The three producing wells have been difficult to complete because of water problems.

Of the new Miocene areas, the outstanding discovery is probably

Bayou Sale, St. Mary Parish, where the Humble Oil and Refining Company has developed a very favorable field in sands at the depth of 10,100 feet. Eight wells have been completed and it is indicated that the area of production will be large. A second promising area has been discovered at *Lake Chicot* in St. Martin Parish, where the Amerada and the Phillips have found two productive sands on a poorly defined, deep-seated dome. The discovery well, State No. 1, was completed in September, in Miocene sand at 9,025–9,040 feet, with one additional well finished since that date.

At *St. Gabriel*, Iberville Parish, Geo. Echols found a very promising new area on a block of leases that was farmed out by the Shell Oil Company, Inc., after the completion of several deep dry holes. The very strongly uplifted area of the dome is complicated by faulting. Since discovery, Echols and the Shell have completed 20 oil wells with a daily production of 4,150 barrels.

Miocene discoveries that do not look too promising in the early stages of development include: *Bastian Bay*, Plaquemines Parish, an old Texas Company prospect where two dry holes had been drilled below 12,000 feet prior to discovery; *Belle Isle*, St. Mary Parish, one of the five islands, a piercement dome where a small flank well appears to be of little importance; and *Pointe au Fer*, Terrebonne Parish, a deep non-piercement dome, where two dry holes were drilled below 11,000 feet and a third plugged back to make a small oil well at 7,000 feet. In this same category might be mentioned the Superior's discovery at *Pecan Lake*, Cameron Parish, where there is one small oil well in sand at 10,175 feet.

Several new gas-distillate areas were opened in the Miocene. *Delacroix*, Plaquemines Parish, is a deep dome, with one gas-distillate well at 8,900 feet. This area may have considerable merit. *Lakeside*, Cameron Parish, is a poorly defined uplift where the Superior Oil Company of California has completed two gas-distillate wells below 9,900 feet. *Lapyrouse*, Terrebonne Parish, has one shut-in gas-distillate well completed by the Gulf Refining Company at 10,883–10,894 feet.

At the lower end of the active Mississippi delta, The Texas Company made a discovery at the *Delta Duck Club*. This is in Plaquemines Parish. Three wells have now been completed in sand at 11,400 feet. In extreme eastern Louisiana, W. T. Burton has an oil well at 9,865 feet, which he has been unable to complete satisfactorily. This is on the *Unknown Pass* prospect, Orleans Parish. A short distance west, along the Mississippi, a Shell Oil Company farm-out in the *Westwego* area, Jefferson Parish, has three producers in sands of Miocene age between depths of 9,000 and 10,000 feet. The wells are difficult to complete and there is little known about the area.

EXTENSIONS

The record of new sands and extensions to proved fields has been a favorable one in 1941. At *Venice*, Plaquemines Parish, an area that has been outstanding for several years past, the Tide Water Associated Oil Company has developed three aditional zones that seem to have great promise. At *Gueydan*, Vermillion Parish, the Fohs Oil Company has located four additional sands. At *West Bay*, Plaquemines Parish, at the extreme tip of the delta, the Gulf and the Tidewater have been very fortunate in setting up new reserves for this dome. *University*, Baton Rouge Parish, had an important extension when Wm. Helis and others found promising new production in the Frio sand at 9,575 feet. Oil is produced from the Miocene at 6,500 feet. The reserve status of numerous other fields has also been improved during the year.

AREAS UNDER EXPLORATION

The practice followed in previous years, of designating the background of structural study that has led to discovery, has been abandoned because of the tiresome repetition that was involved. Practically all coastal discoveries of to-day result finally from an analysis of geophysical data, although there are instances where flank discoveries on piercement domes that have long been recognized as structural units are the product of geological analysis of drilling data. Two such instances this year are the discoveries at Belle Isle and Pine Prairie.

For the past few years, the region of most intensive exploratory activity in the upper Texas Coast has been the downdip Wilcox trend and the favorable results of this year's work are evidence that this activity will continue. Otherwise, the deep coastal territory continues to be reworked with more refined geophysical methods, but the low-grade prospects that have resulted from this closer study are not very encouraging. In coastal Louisiana, the results of Wilcox exploration have not been profitable but there is still much delta territory that justifies closer study, thereby reducing the urgency to concentrate on the Wilcox that exists in Texas. There are indications, however, that the upward trend of the discovery rate may have reached its peak in Louisiana, and that future discovery data may list fewer of the major, thick sand areas and more of the small second-rate areas such as those that have so conspicuously dominated recent reports from the upper Texas Coast.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 991-999, 5 FIGS.

DEVELOPMENTS IN SOUTHEASTERN UNITED STATES IN 1941[1]

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Jackson, Mississippi

ABSTRACT

Outstanding development trends in the southeastern United States during 1941 were the following:

1. A decided decrease in wildcat activity with only approximately half the number of wells completed as during 1940.
2. The continuation of a curtailed geophysical program comparable with the last months of 1940 with a slight upturn toward the end of the year.
3. The inception of core-drilling programs by eight major companies with more emphasis placed on this type of exploration, as well as on surface geology.
4. A continuation of the leasing program in south Mississippi and its extension into Alabama and Florida.
5. The review and revision of geological and geophysical data with an attempt to eliminate the sources of error as revealed by negative results of exploration in 1940.

There were several additional events of importance in the area. Development in the Tinsley field seemingly outlined the limits of production from the shallow sands. A new sand, the McGraw, was discovered on the north edge of the field in the basal part of the Eutaw formation.

Two new fields were discovered in Mississippi, the Sharpsburg field in T. 11 N., R. 3 E., Madison County, and the Cary field in T. 11 N., R. 7 W., Sharkey County. The Sharpsburg field which may be an extension of the near-by Pickens field was discovered by C. L. Morgan's Johnny No. 1, Sec. 4, T. 11 N., R. 3 E. The producing sand is known as the Wilburn and is the first sand in the Eutaw formation. The Cary field was opened by the British-American Oil Company's Houston No. 1, Sec. 23, T. 11 N., R. 7 W., producing from Selma gas rock of Navarro age. Neither area has had sufficient exploration to evaluate the future.

Of geological importance was the limiting of the Mississippi salt basin on its northeast side by the Union Producing Company's Waite No. 1 in Clarke County, Alabama, and the Magnolia Petroleum Company's Culpepper No. 1 in Lauderdale County, Mississippi. The Union Producing well drilled to a total depth of 12,399 feet and near the bottom penetrated formations which are correlated with the Buckner, Smackover, and Eagle Mills formations of Louisiana and Arkansas. In the Eagle Mills formation, interbedded shale and salt was cored, suggesting proximity to the edge of the salt deposit. The Magnolia well in Lauderdale County encountered rocks of Paleozoic age at the depth of 6,060 feet, so that the limit of the salt deposit is between these two wells. Of first importance geologically is the presence of the Smackover limestone, indicating its presence across the Mississippi Basin into Alabama. This suggests the possibility of production in porous zones comparable with producing areas in Arkansas and Louisiana.

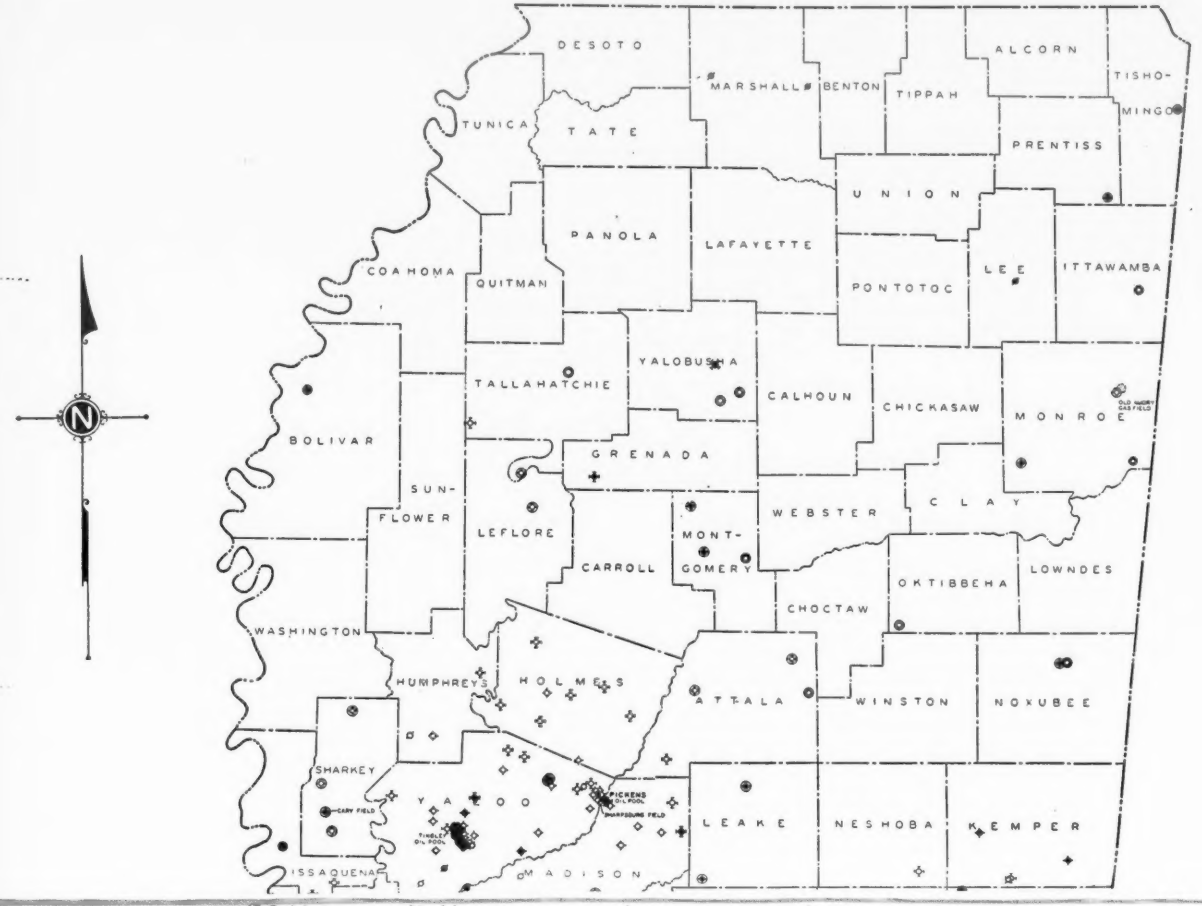
Alabama and Florida came in for extensive geophysical and leasing activity. In the latter state many of the large tracts were taken under geophysical option or otherwise leased. The same was true of southern Alabama and to a less degree, southern Mississippi. Nothing of importance occurred in Georgia.

Two new salt domes were discovered in Mississippi. Kings dome was found by the Magnolia Petroleum Company's Hall No. 1, Sec. 17, T. 7 N., R. 4 E., Warren County. The Halifax dome was discovered by the Plains Producing Company in Sec. 1, T. 7 N., R. 4 W., Hinds County.

The Magnolia Petroleum Company's Hall No. 1 encountered a saturated section in the top of the Wilcox formation. A test resulted in showing the presence of low-gravity asphaltic oil and water. Although this had no commercial value, the presence of oil in the top of the Wilcox formation was indicative of its productive possibilities elsewhere.

[1] Presented before the Association at Denver, April 22-24, 1942. Manuscript received, April 18, 1942.

[2] Consulting geologist, 105½ West Capitol Street.


DESOTO
MARSHALL
BENTON
TIPPAH
ALCORN
TISHO-
MINGO
TUNICA
TATE
PRENTISS
UNION
PANOLA
LAFAYETTE
COAHOMA
QUITMAN
PONTOTOC
LEE
ITTAWAMBA
TALLAHATCHIE
YALOBUSHA
CALHOUN
CHICKASAW
MONROE
BOLIVAR
GRENADA
SUN-
FLOWER
LEFLORE
WEBSTER
CLAY
MONT-
GOMERY
CARROLL
OKTIBBEHA
LOWNDES
CHOCTAW
WASHINGTON
HUMPHREYS
HOLMES
ATTALA
WINSTON
NOXUBEE
SHARKEY
YAZOO
LEAKE
NESHOBA
KEMPER
ISSAQUENA
MADISON
WARREN
SCOTT
NEWTON
LAUDERDALE

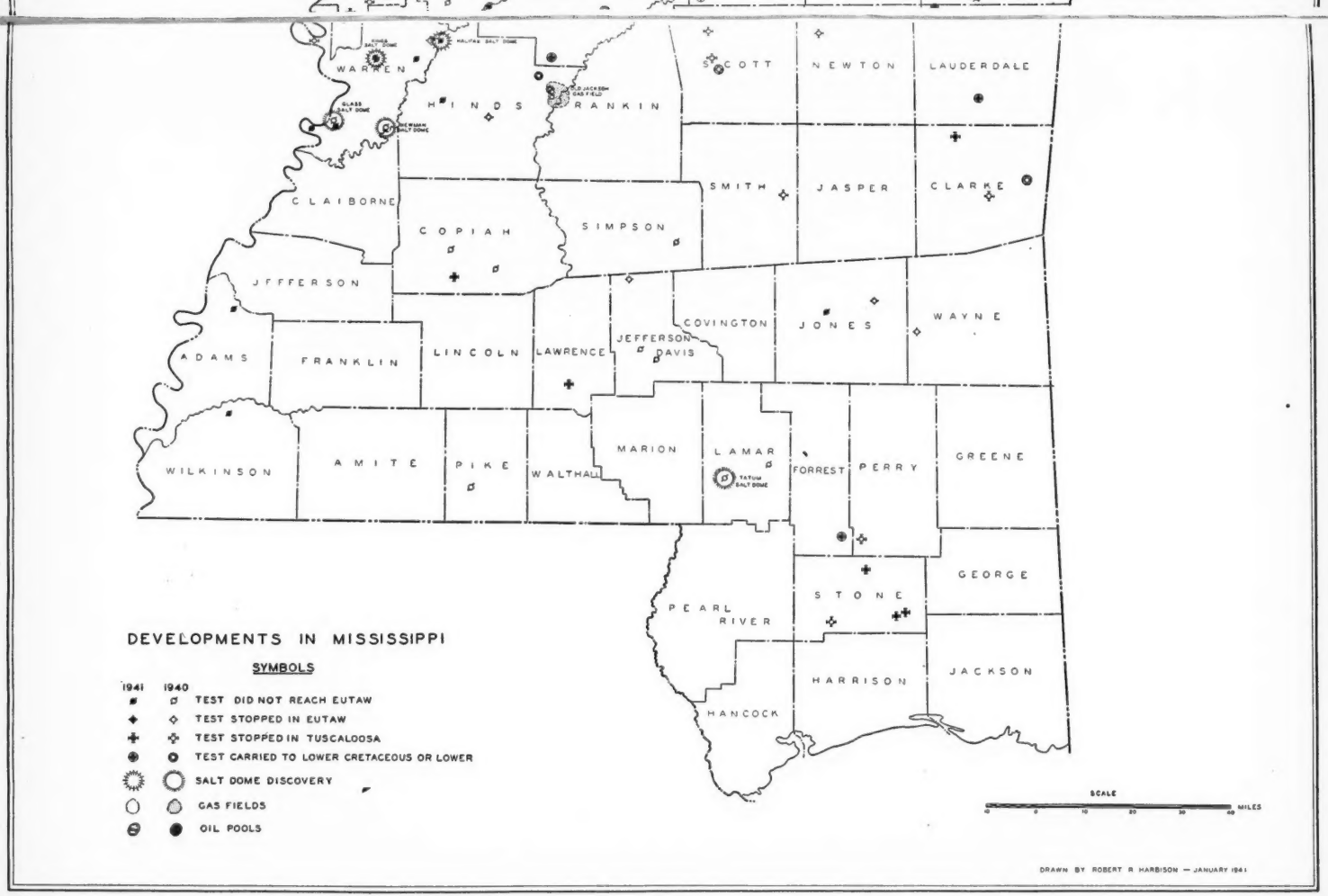

WARREN
HINDS
RANKIN
SCOTT
NEWTON
LAUDERDALE
SMITH
JASPER
CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
ADAMS
FRANKLIN
LINCOLN
LAWRENCE
JEFFERSON DAVIS
COVINGTON
JONES
WAYNE
WILKINSON
AMITE
PIKE
WALTHALL
MARION
LAMAR
FORREST
PERRY
GREENE
GEORGE
STONE
PEARL RIVER
HARRISON
JACKSON
HANCOCK
DEVELOPMENTS IN MISSISSIPPI
SYMBOLS
1941 1940
TEST DID NOT REACH EUTAW
TEST STOPPED IN EUTAW
TEST STOPPED IN TUSCALOOSA
TEST CARRIED TO LOWER CRETACEOUS OR LOWER
SALT DOME DISCOVERY
GAS FIELDS
OIL POOLS
SCALE
MILES
DRAWN BY ROBERT R HARBISON — JANUARY 1941

FIG. 1

DEVELOPMENT TRENDS

During 1941, activity in the southeastern United States was largely confined to Mississippi. Alabama ranked second, with Florida and Georgia following in the order named; South Carolina was the only state in this geographical unit wholly inactive.

Following the disappointing results of wildcat drilling during the preceding year, there was a shift in the types of exploration used. During 1940, geophysical methods were used almost exclusively; in 1941, however, other types of work were adopted. During the year, seven major companies carried on core-drilling programs. New data made it possible to refine subsurface maps. At the same time, discovery of sources of error in seismograph work made it possible to correct earlier mistakes and to avoid them in current work.

There was a gradual shifting in activity from Mississippi eastward, Alabama and Florida receiving the most attention, along with south Mississippi. By the end of the year most of the large holdings controlled by lumber companies had been placed under contract.

The limits of the Tinsley field were practically outlined insofar as the upper formations were concerned, as the salt-water level was reached on all sides of this field. Only one new sand was discovered during the year; it is known as the McGraw sand and is probably a lenticular sand in the basal part of the Eutaw formation of Upper Cretaceous age.

The most important event geologically was the discovery of the presence of Smackover limestone in southwestern Alabama, showing that this formation, which is productive in Arkansas, extends across the Mississippi embayment and presumably under much of Mississippi. The Union Producing Company's Waite No. 1, Clarke County, Alabama, was drilled to 12,399 feet and near the bottom penetrated the Buckner limestone, Smackover limestone, and Eagle Mills formation of Jurassic age. In the Eagle Mills formation salt was found interbedded with red shale, the latter being discolored with the red stain from the shale. This suggests that this well was drilled near the edge of the salt deposit and limits it on the northern flank side of the basin. This interpretation is further borne out by the results of the Magnolia Petroleum Company's Culpepper No. 1, Lauderdale County, Mississippi; this well encountered rocks of Paleozoic age at 6,060 feet and is beyond the limits of the salt basin.

Two new fields were discovered, neither of which had been sufficiently drilled by the end of the year to forecast their importance.

The first of these was the Cary field, T. 11 N., R. 7 W., Sharkey County, Mississippi, drilled by the British-American Oil Company.

It produces from Selma gas rock of Navarro age and it made 40 barrels of oil daily, initially, and considerable salt water.

The Sharpsburg field was discovered by C. L. Morgan's Johnny No. 1, Sec. 4, T. 11 N., R. 3 E., Madison County, Mississippi. The producing sand is the Wilburn which is the first sand in the Eutaw formation and is correlative with the producing sand in the Pickens field, Yazoo County, Mississippi. The exact relationship between these fields was not clear but it seemed likely that they were distinct producing areas and seemingly of small extent.

Two new salt domes were discovered. The Magnolia Petroleum Company's Hall No. 1 discovered the Kings dome, Sec. 17, T. 7 N., R. 4 E., Warren County, Mississippi. Above the salt more than 30 feet of saturated sand was found in the top of the Wilcox formation; a test showed the presence of low-gravity asphaltic oil and water, but it was not a commercial producer. The presence of this showing pointed to the possibility of production in the Wilcox formation in southeastern United States; the results in this well seem to be one of the high-lights of the year.

The Halifax dome was discovered by the Plains Producing Company, Sec. 1, T. 7 N., R. 4 W., Hinds County, Mississippi.

At least two other salt domes were reported as discovered, but no information regarding them was available.

DRILLING ACTIVITY

There was a decided falling off in wildcat activity in this area, with only approximately half the number of completed wells as recorded during 1940. Two hundred nineteen producers were drilled in Mississippi, 217 being located in the Tinsley field, 1 in the Cary field, and 1 in the Sharpsburg field. Seventy-six dry holes were drilled in Mississippi: 20 in the Tinsley field proper, 6 in Yazoo County, and 50 in the other parts of the state.

In Alabama, 12 dry holes and no producers were drilled. There were no completions in Florida during 1941; only 4 operations were reported, and one of these, the Florida Oil Discovery Company's Cedar Keys No. 2 was drilled to 6,000 feet. No drilling was reported in Georgia and South Carolina. The total number of wells completed in the area was 307.

LEASING ACTIVITY

There was a sharp decline in leasing activity in Mississippi during the year except in the south part of the state, where the last large tracts of lumber company cut-over land were placed under contract.

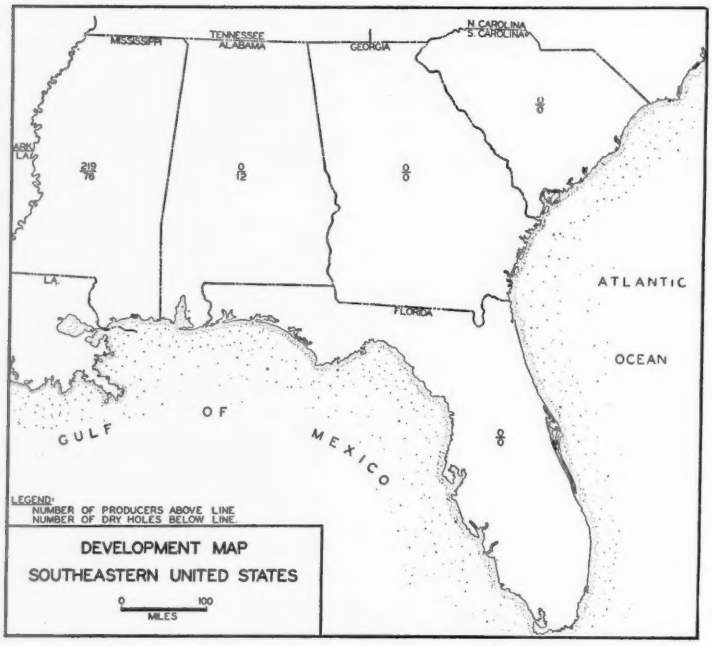

MISSISSIPPI
TENNESSEE
ALABAMA
GEORGIA
N. CAROLINA
S. CAROLINA
ARK.
LA.
219
76
0
12
0
0
0
0
LA.
FLORIDA
ATLANTIC
OCEAN
GULF
OF
MEXICO
LEGEND:
NUMBER OF PRODUCERS ABOVE LINE
NUMBER OF DRY HOLES BELOW LINE
DEVELOPMENT MAP
SOUTHEASTERN UNITED STATES
0
100
MILES

FIG. 2

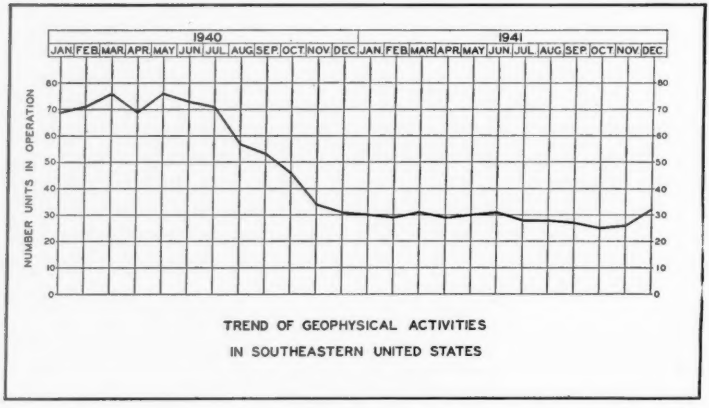

1940
1941
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
NUMBER UNITS IN OPERATION
80
70
60
50
40
30
20
10
0
TREND OF GEOPHYSICAL ACTIVITIES
IN SOUTHEASTERN UNITED STATES

FIG. 3

Most of the major company leases were maintained, but some were allowed to lapse through non-payment of rentals; also an effort was made by some of the lessors to secure a reduction in the rental terms.

In Alabama, there was a continuation of the lease play which was begun in 1940. The number of companies participating in this activity was small, but those parts of south Alabama which were considered most attractive were largely placed under lease.

In Florida, both major companies and independents were active in leasing throughout the state; all the submerged lands on the west coast were leased and many of the large holdings were placed under contract.

In Georgia, there was slight lease activity; none was reported from South Carolina.

GEOPHYSICAL ACTIVITY

The amount of geophysical work being carried on at the end of 1940 was continued through 1941. Of the total number of crews approximately two-thirds were located in Mississippi, the remainder being in the other states, mostly Alabama and Florida. Figure 3 shows the number of geophysical parties active at the end of each month for 1940 and 1941.

PRODUCTION

All of the production in the southeastern United States came from Mississippi. The grand total of oil produced was 15,500,651 barrels, divided as follows.

Field	*Wells*	*Barrels*
Tinsley	327	15,279,323
Pickens	3	209,997
Cary	1	3,758
Sharpsburg	1	7,753

MISSISSIPPI PRODUCTION IN 1941

	Tinsley	*Pickens*	*Cary*	*Sharpsburg*
January	556,100	27,826		
February	547,033	19,203		
March	584,679	20,958		
April	762,102	19,430		
May	899,775	17,648		
June	851,488	16,558		
July	1,460,021	16,678		
August	1,550,345	16,983		
September	1,632,393	14,698	844	
October	1,966,365	13,504	934	
November	2,229,949	13,534	902	
December	2,237,165	12,977	898	7,753

The total cumulated production for the state was 20,111,894 barrels. Figure 4 shows the production trend during 1940 and 1941.

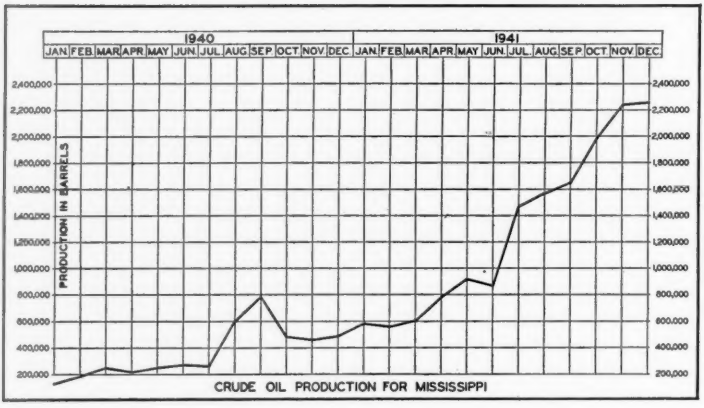

1940
1941
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
PRODUCTION IN BARRELS
2,400,000
2,200,000
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
CRUDE OIL PRODUCTION FOR MISSISSIPPI

FIG. 4

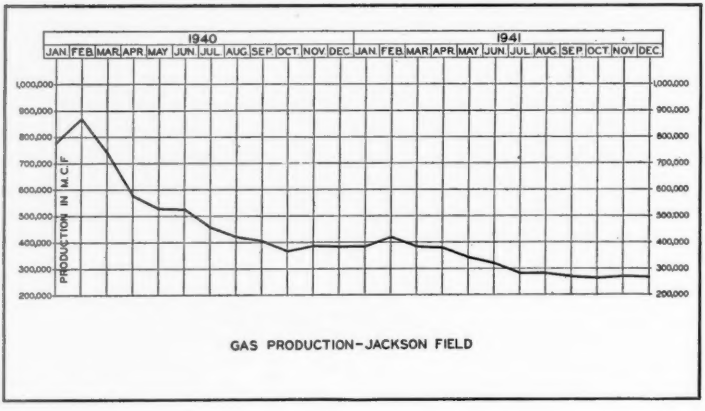

1940
1941
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
PRODUCTION IN M.C.F
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
GAS PRODUCTION-JACKSON FIELD

FIG. 5

	Gas Field	
	1940	*1941*
January	779,159	387,693
February	871,395	421,930
March	740,835	384,568
April	577,671	379,489
May	529,393	343,922
June	515,669	321,197
July	461,670	281,884
August	423,951	282,405
September	407,524	269,013
October	366,468	266,258
November	388,305	271,902
December	386,397	268,211
Total	6,448,737	3,878,472

The Jackson gas field accounted for the total gas production in the area. Figure 5 shows the productive history of this field for the years 1940 and 1941.

CONCLUSION

During 1940 the southeastern district was still in the early stages of exploration. Many errors of method have been discovered and were being eliminated. The Tinsley field was outlined so far as the Woodruff zone was concerned, but the limits of production in none of the deeper formations had been established. No attempt was made to drill deeper than depths formerly reached. The presence of Smackover limestone in southwestern Alabama pointed to its presence under a large part of the area and opened new possibilities for deeper drilling. All work was moving at a slower tempo and had gained much in accuracy as a result.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1000-1006, 2 FIGS.

DEVELOPMENTS IN SOUTH TEXAS DURING 1941[1]

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ABSTRACT

The development in South Texas during 1941, except for the Wilcox sand, has shown no important discoveries.

No construction of new recycling plants was in progress at the end of the year. Old plants were being renovated to improve their recoveries.

Paleontology, neglected in recent years, is important in correlating wells.

A regional structural feature, the "Vicksburg flexure," is being recognized as the controlling factor for large oil and gas accumulation in southwest Texas.

INTRODUCTION

The area included in this report is shown in Figure 1. The Llano-Burnet uplift, the Republic of Mexico, and the Gulf of Mexico furnish three natural boundaries. The tentative boundary between the South Texas area and the upper Gulf Coast area of Texas has been placed along the east lines of Calhoun, Jackson, Lavaca, Fayette, Burleson, and Milam counties.

The national defense program and increase in Federal tax schedules influenced development programs of most operators in this area in 1941. The tax situation, specifically, had a detrimental effect on the financing of proposed recycling projects.

Favorable structural prospects were drilled in Jackson County, Starr County, and along the Wilcox trend. Otherwise, most wildcatting resulted from lease situations and drilling obligations.

DEVELOPMENT

The amount of drilling during the year, especially wildcat, reflected the "tightening," which resulted from the war. Temporarily, after Pearl Harbor, this pace increased and at the end of the year much activity was observed; however, this soon waned.

The prorating of material, especially casing, caused much comment, but until the last few days of the year all necessary materials were available for any legitimate project or endeavor.

By the beginning of 1941, the production of South Texas had adjusted itself to the loss of foreign markets, a factor which upset its routine during the previous year. Except for emphasis on crudes, yielding high-octane gasolines, the markets remained at an even keel until the declaration of war.

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, April 10, 1942.

[2] Geologist, 701 Driscoll Building.

DISCOVERIES

Again, the reserves added by newly discovered areas were small; also, the number of such discoveries dwindled to a low ebb.

TABLE I
FIELDS DISCOVERED IN 1941

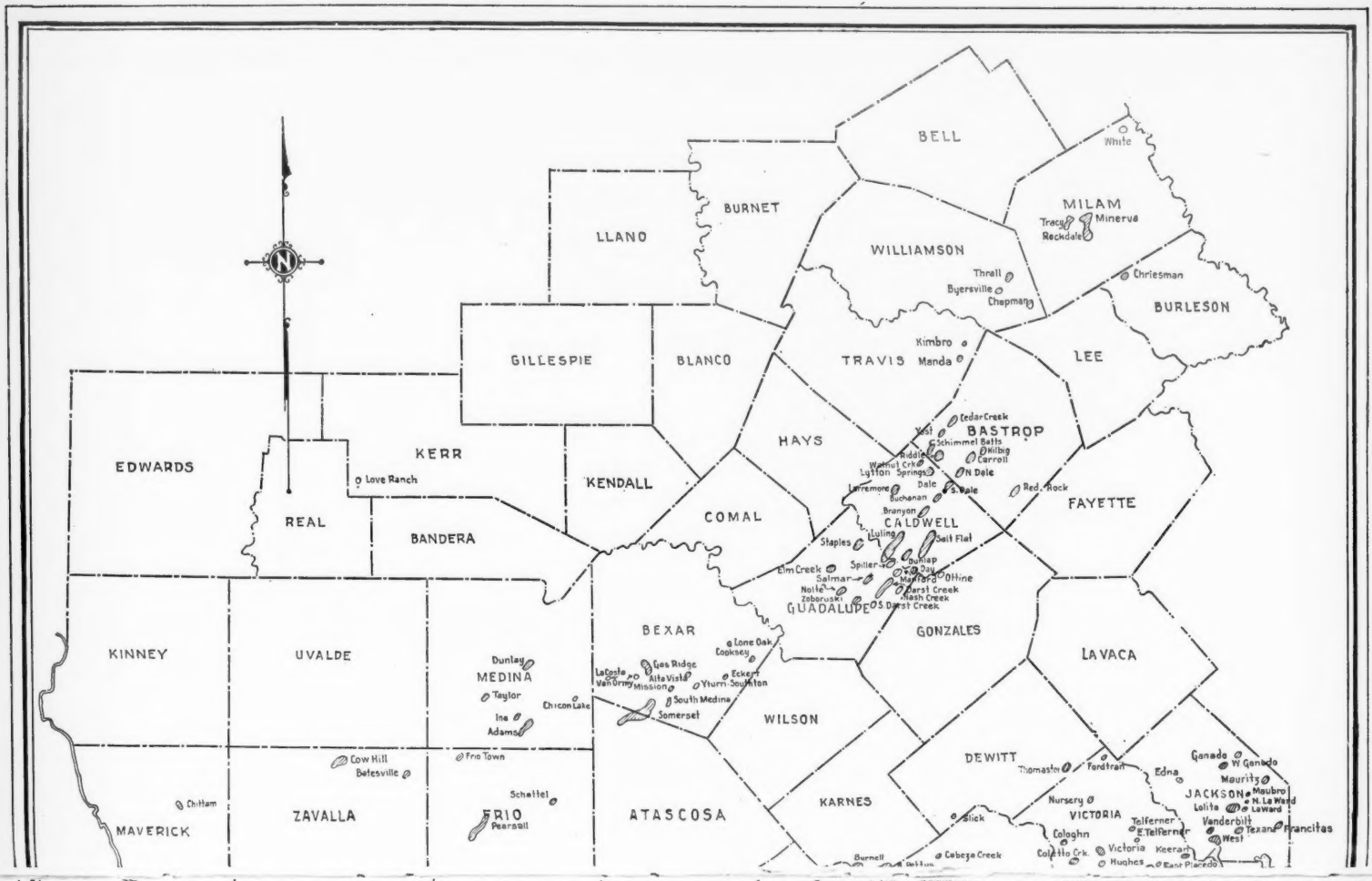
Field Name	*County*	*Depth of Discovery Sand in Feet*	*Producing Formation*	*District*	*Initial Production Per Day*	*Choke (Inches)*
Chaparosa	Jim Hogg	2,855–2,863	Jackson	Laredo	Gas well	
Carrizo	Dimmit	2,292–2,298	Navarro	Laredo	72	Pump
Coloma Creek	Calhoun	5,890–5,892	Frio	Corpus Christi	Gas-dist.	
West Colorado	Jim Hogg	1,998–2,001	Jackson	Laredo	Gas well	
Elgin	Bastrop	2,830–2,850	Austin chalk	San Antonio	104	Pump
Genevieve	Bee	4,169–4,178	Jackson	Laredo	40	5/32
Haldeman	Jim Wells	5,038–5,040	Frio-Vicksburg	Corpus Christi	106	1/8
Heard	Bee	4,764–4,767	Jackson	Laredo	12,000 MCF	1/8
Henshaw	Jim Wells	5,140–5,144	Frio	Corpus Christi	95	1/8
Lentz	Bastrop	2,226–2,246	Dale limestone	San Antonio	248	3/8
Maubro	Jackson	5,220–5,230	Frio	Corpus Christi	501	1/4
Nichols	Hidalgo	3,481–3,502	Frio	Corpus Christi	86	9/16
N. LaWard	Jackson	5,207–5,226	Frio	Corpus Christi	122	1/8
Petronilla	Nueces	7,308–7,312	Frio	Corpus Christi	209	1/8
Rios	Duval	6,260–6,290	Jackson	Laredo	15	3/16
So. White Creek	Live Oak	1,844–1,852	Jackson	Laredo	680	1/2
So. Campana	McMullen	3,012–3,023	Pettus	Laredo	96	3/8
So. Dale	Caldwell	1,998–2,252	Dale limestone	San Antonio	8	Pump
Steamboat Pass	Calhoun	2,880–2,885	Catahoula	Corpus Christi	32,000 MCF	
Woodsboro	Refugio	5,900–5,903½	Frio	Corpus Christi	55	7/16
Yturria, Sun	Starr	4,232–4,233½	Frio-Vicksburg	Corpus Christi	16	7/64

Initial production in barrels, for oil; MCF indicates 1,000 cubic feet gas production.

One major development, and probably the most important, was the completion of good oil wells in the Wilcox sands in the Washburn area, La Salle County, and in the old Caesar pool, Bee County. Previously, several well recognized structures had proved disappointing in beds of this producing age, and these discoveries revived a trend in which operators were losing faith. Pertinent data on these developments have been omitted; they are being made the special subject of another paper.

Twenty-two new producing areas were added; seven were gas areas of questionable value; ten were oil areas, which added small reserves, and five were oil pools, containing important, but not major reserves. The most important discoveries among the oil fields were Yturria, Starr County, and Maubro and North LaWard, Jackson County.

One circumstance, which must be borne in mind in estimating recently discovered areas, is that stricter proration of production and larger spacing for wells necessitate extreme caution in developments. This increases the length of time necessary to establish information on the oil or gas accumulations. Unless a discovery well is an exceptionally good producer with offsets, requiring immediate drilling, and with favorable pipe-line outlets, several months are required for developments to get into full swing.


BELL
White
MILAM
Tracy
Minerva
Reckdale
BURNET
LLANO
WILLIAMSON
Thrall
Byersville
Chapman
Chriesman
BURLESON
GILLESPIE
BLANCO
TRAVIS
Kimbro
Manda
LEE
HAYS
Cedar Creek
West
BASTROP
Schimmel
Batts
Kilbig
Carroll
Riddle
Walnut Crk
Lytton Springs
N Dale
Dale
S Dale
Red Rock
EDWARDS
KERR
Love Ranch
KENDALL
Lairemore
Buchanan
Branyon
FAYETTE
REAL
BANDERA
COMAL
CALDWELL
Luling
Salt Flat
Staples
Dunlap
Spiller
Day
Elm Creek
Salmar
Mayford
Ottine
Nolte
Zoborusky
Darst Creek
Nash Creek
S. Darst Creek
GUADALUPE
KINNEY
UVALDE
BEXAR
Lone Oak
Cooksey
Gas Ridge
LaCoste
Alta Vista
Eckert
Von Ormy
Mission
Yturri-Southton
MEDINA
Dunlay
Taylor
Chicon Lake
South Medina
Ina
Adams
Somerset
WILSON
GONZALES
LAVACA
Cow Hill
Frio Town
Batesville
Schattel
Chittam
MAVERICK
ZAVALLA
FRIO
Pearsall
ATASCOSA
KARNES
DEWITT
Thomaston
Fordtran
Edna
Ganado
W Ganado
Mauritz
JACKSON
Maubro
N La Ward
Laward
Lolita
Nursery
VICTORIA
Telferner
E Telferner
Vanderbilt
Texana
Francitas
West
Slick
Cologhn
Coletto Crk
Victoria
Keeran
Hughes
East Placedo
Burnell
Cabeza Creek
Caesar
Whitsett
Crowther
Carrizo
GOLIAD
Pettus
Weesis
Plummer
Greyburg
Burke
E Tuleta
Fannin
Placedo
Meyser
Port Lavaca
Labbhia
Mc Faddin

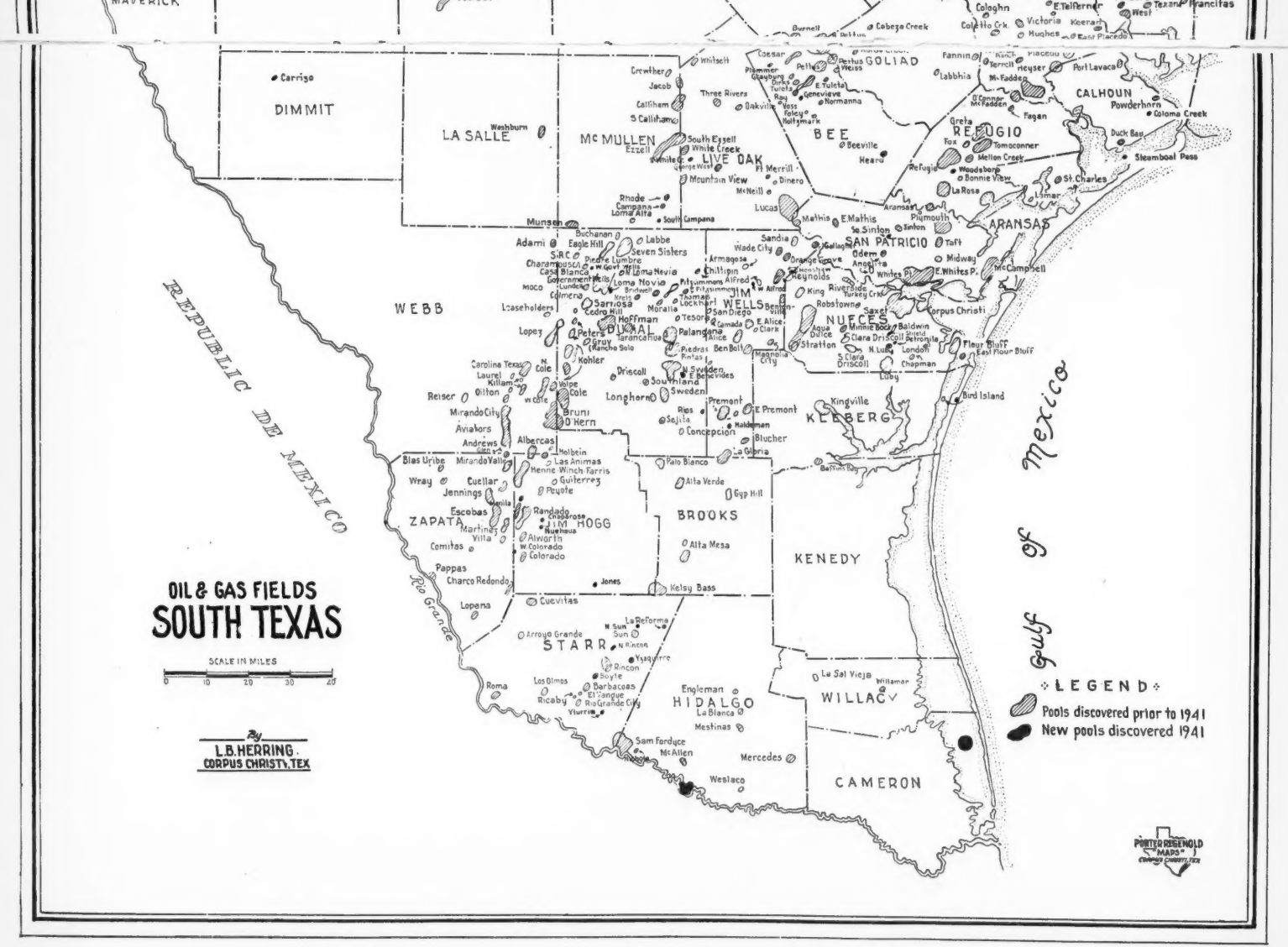

OIL & GAS FIELDS
SOUTH TEXAS
SCALE IN MILES
0 10 20 30 40
By
L.B. HERRING
CORPUS CHRISTI, TEX
REPUBLIC DE MEXICO
Rio Grande
Gulf of Mexico
DIMMIT
LA SALLE
McMULLEN
LIVE OAK
BEE
GOLIAD
REFUGIO
CALHOUN
ARANSAS
SAN PATRICIO
NUECES
KLEBERG
KENEDY
WILLACY
CAMERON
HIDALGO
STARR
ZAPATA
JIM HOGG
BROOKS
JIM WELLS
WEBB
DUVAL
MAVERICK
LEGEND
Pools discovered prior to 1941
New pools discovered 1941
PORTER REGENOLD MAPS

FIG. 1

Again, pools discovered in previous years received the most important developments. At Agua Dulce, Nueces and Kleberg counties, zones previously producing were being continuously extended, and new producing zones, whose permeabilities and porosities indicate high recoveries, were being added. East Premont, Jim Wells County,

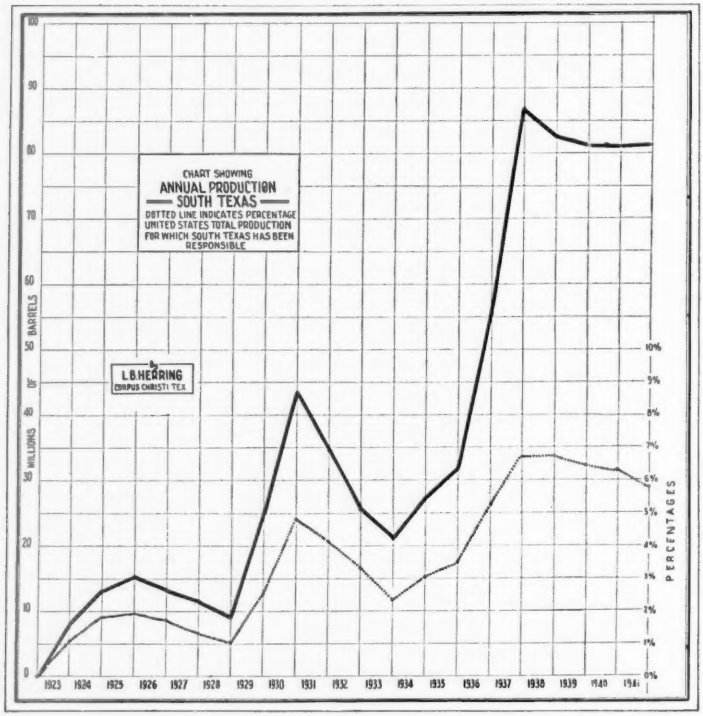


FIG. 2

is another old area which rose into prominence. Several oil sands proved productive along the south and southwest flank of this structure. Some of them contain gas over the apex, while others are lenses. This pool has the earmarks of developing into a major reserve.

Other fields which receive important developments were Odem in San Patricio County, and Kelsey in Brooks and Starr counties.

Developments in the pre-Eocene area around San Antonio added practically nothing, and developments in the Eocene, except for the Wilcox, discovered no important areas.

PRODUCTION

The only important increase in oil production was in Jackson County, where the increase was more than 3 million barrels. This was sufficient to offset other declines and allow the South Texas area a total annual production of 81,340,000 barrels, which was a slight increase over the preceding year. Production in the San Antonio area took a sudden drop. Production in the Eocene beds declined, although there was an unusual demand for that crude. The percentage of national yield dropped from 6.29 per cent to 5.8 per cent.

PRESSURE MAINTENANCE

Considerable interest was shown during the year in maintaining the pressure in oil fields by the injection of gas. Pressure maintenance projects of this type were either commenced or completed at the following fields: Plymouth, San Patricio County; Luby, Nueces County; North Sweden, Duval County; Loma Novia, Duval County; and Rincon, Starr County.

These projects will add to the ultimate oil recovery in all these pools, especially those without an effective water drive. Pools with this handicap are present in South Texas.

EXPLORATION WORK

Except for the Wilcox trend, geophysical exploration was at a standstill. This type of exploration has gradually decreased during the last 3 or 4 years.

Added interest has been manifested in shallow core drilling in the areas of Miocene and Oligocene production. Test work over known folds has shown that, in certain trends, structure is reflected in the Pliocene, and probably in the Pleistocene beds. In this work, electrical logs are used as a basis for correlations.

PALEONTOLOGY

The information accompanying electrical logs solved so many problems and was so revealing that geologists in South Texas tended to look upon it as a "cure-all." This brought about a laxity in saving drilling samples, as it was felt by many that the information to be received from them would be superfluous. Producing areas have been developed in which electrical logs can not be accurately correlated, because of unconformities, faulting, and extremely erratic sand conditions. Paleontology and lithologic study of the samples aid in solving these problems, and in some instances furnish definite correlations in producing zones which otherwise would be indeterminable.

Strange as it may seem, some geologists have been reluctant in saving samples; and it has been necessary for interested geologists to re-educate them in their value.

"VICKSBURG FLEXURE"

In November, 1939, Alexander Deussen and K. D. Owen[3] called attention to a structural belt, extending across South Texas and paralleling the coast, which they termed the "Vicksburg flexure." This belt is evidenced by a sudden downdip thickening in the lower Frio and Vicksburg beds, and can be measured in thousands of feet. Closely associated with this flexure are anticlines, faults, unconformities, and sand wedges, all of which contribute traps for oil and gas accumulations. This is being recognized as the outstanding regional structural feature of the Gulf Coastal area of South Texas. It can be traced intermittently from Jackson County through Victorio, Refugio, San Patricio, Nueces, Jim Wells, Brooks, and Starr counties.

Classic structural features along this trend are: the Refugio pool, Refugio County; the Agua Dulce pool, Nueces County; and the Rincon pool, Starr County.

CONDENSATE

The construction of one new gas-recycling unit was commenced during the year; one major unit at La Gloria, Jim Wells County, was completed and started recycling operations. Exploratory drilling at Sejita, Duval County, verified the belief that reserves were sufficient to justify a plant; however, contemplated construction has not begun. Except for this project, no new plant construction is anticipated.

The major development in recycling plants was the rebuilding of the older plants in order to stabilize and retain the butanes and propanes. Prior to the war, the only commercial demand for these two gas constituents was as liquid gas. They are now in huge demand as the bases for synthetic rubber and 100-octane gasoline.

[3] "Correlation of Surface and Subsurface Formations in Two Typical Sections of the Gulf Coast of Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 23, No. 11 (November, 1939), pp. 1603–34.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1007-1039, 1 FIG.

WEST TEXAS AND SOUTHEASTERN NEW MEXICO DEVELOPMENT IN 1941[1]

WEST TEXAS GEOLOGICAL SOCIETY COMMITTEE[2]
Midland, Texas

ABSTRACT

Development in West Texas in 1941 was greater than in any year since 1937. Two thousand three hundred twenty-five wells were drilled, including those deepened and recompleted. Of these 2,190 or 94 per cent were producers. The most active field was the Slaughter field which accounted for 678 wells or more than one-fourth of the producers drilled. One hundred thirty-five wildcat wells (wells more than one mile from production) were drilled, of which 27 were producers and 108 were dry holes. Nine of the wildcat wells established new areas of production; the remainder were produced from new levels in established areas or were considered extensions. Fifteen of the wildcats were completed from the various known Permian levels while two new levels, both in the Lower Permian, were disclosed. Permian exploration was scattered over 43 counties and was more inclusive in the number of zones tested than in previous years.

Especially did pre-Permian drilling and exploration exceed that of past years. One hundred six pre-Permian wells were completed. Of this number, 21 were dry, 6 were plugged back to the Permian for producers, and one was a temporarily abandoned gas well. Thus, the dry holes amounted to 15 per cent. Twenty-five of the pre-Permian tests could be considered wildcats and of these 10 were successfully completed as producers. The center of activity was in the Abell field in north-central Pecos County. Here 56 wells were completed, including 6 wildcat producers, 1 dry hole, 6 wells which were plugged back to the newly discovered Permian zones, and a temporarily abandoned gas well.

A definite trend toward deeper drilling has been accelerated by new discoveries in the Lower Permian (Leonard), Lower Pennsylvanian ("Strawn"), and Ordovician and Cambrian (Simpson and Ellenburger) groups.

There was a decline of 31.5 per cent in the number of wells drilled in southeastern New Mexico in 1941. Three hundred seventy-one wells were drilled, of which 294 were oil wells, 7 gas wells, and 70 dry holes—the highest percentage of dry holes in the past several years. There were four new discoveries for the year. The most active area was the Maljamar pool, where 61 wells were completed including 3 which were dry. The producing formations of the 1941 discoveries are the Yates, Seven Rivers, and Grayburg.

Geophysical activity has been conducted mainly with gravimeter and magnetometer.

INTRODUCTION

The number of wells drilled in West Texas in 1941 was greater than in any year since 1937, but in southeastern New Mexico the number was less than in any of the previous four years.

WEST TEXAS OPERATIONS, 1937–1941

	1937	*1938*	*1939*	*1940*	*1941*
Total wells drilled	2,604	2,018	1,854	1,866	2,325
Number of field producers	2,352	1,716	1,640	1,747	2,190
Number of wildcats	166	192	114	119	135
Per cent wildcat successes	22.9	24.0	25.4	39.4	20
Pipe-line runs (millions of barrels)	75.52	74.37	81.91	112.90	117.57

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, April 13, 1942.

[2] Bernerd A. Ray, geologist, Tide Water Associated Oil Company; subject: Pre-Permian of West Texas.

Wm. T. Schneider, geologist, Honolulu Oil Corporation; subject: Permian of West Texas.

Taylor Cole, geologist, University Lands; subject: Permian of West Texas.

Edgar Kraus, geologist, The Atlantic Refining Company; subject: Southeastern New Mexico.

Ronald K. DeFord, geologist, Argo Oil Corporation; subject: Discussion and Revision of Correlation Chart.

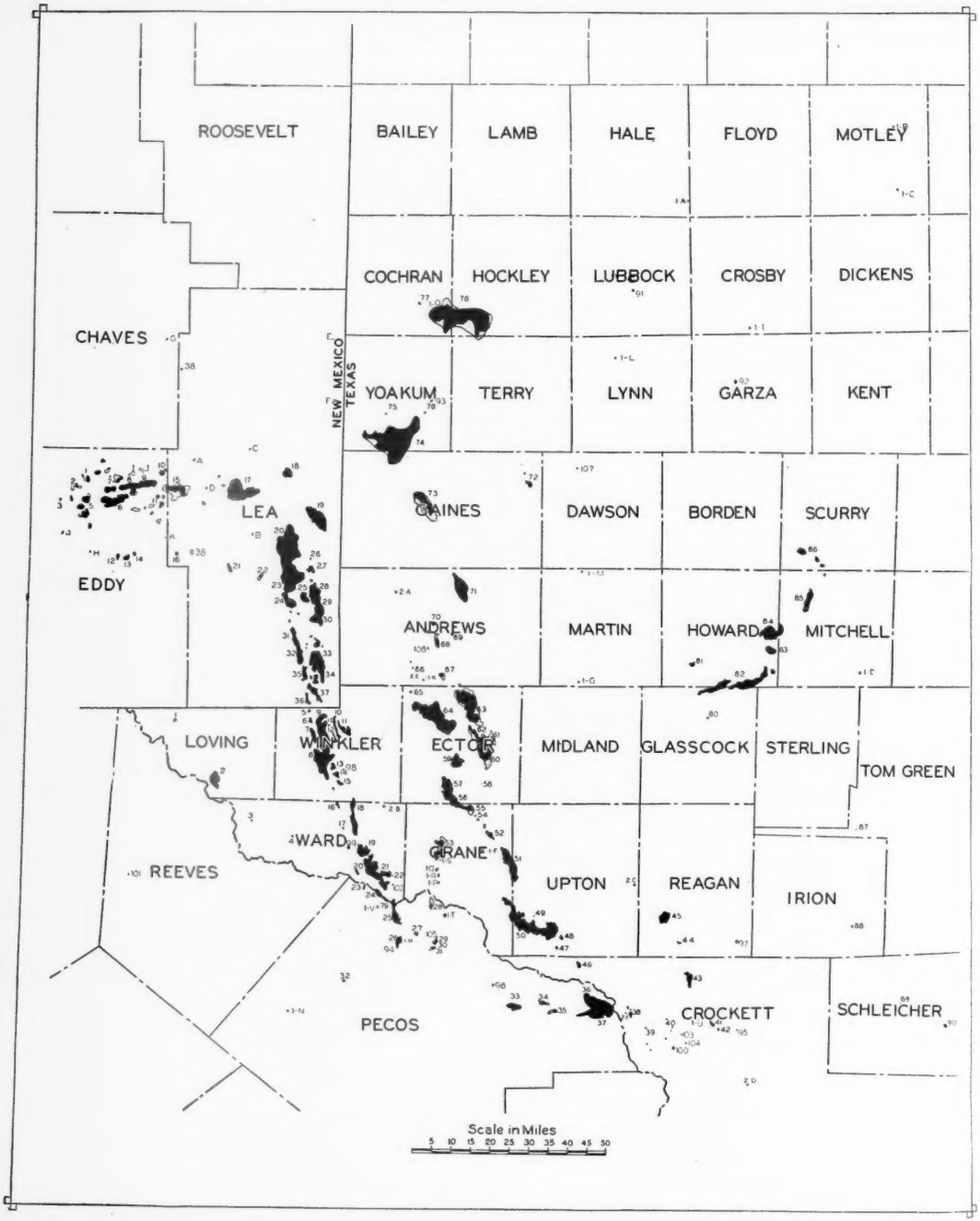


FIG. 1.—Base map of West Texas and southeastern New Mexico, showing location of fields and more important wildcats.

West Texas Fields

1. Mason
2. Wheat
3. Monroe
4. Hayes
5. Eaves
6. Leck
7. Henderson
8. Hendrick
9. Scarborough
10. Keystone (Colby sand)
11. Keystone lime
12. Kermit
13. Emperor deep
14. Emperor
15. Halley
16. Magnolia Sealy
17. Magnolia Sealy South
18. North Ward
19. Estes
20. South Ward
21. Shipley
22. Shipley Silurian
23. Netterville
24. Payton
25. Pecos Valley High Gravity
26. Pecos Valley Low Gravity
27. Lehn
28. Abell
29. Masterson
30. Apco-Warner
31. Fromme
32. Richards
33. Taylor-Link
34. Walker
35. White and Baker
36. Tobarg
37. Yates
38. Noelke
39. Olson
40. Live Oak
41. Todd Deep
42. Wyatt
43. World
44. Grayson
45. Big Lake
46. Crockett
47. Webb-Ray
48. Hurdle
49. Herrington
50. McCamey
51. McElroy
52. Dunes
53. Sand Hills Permian and Sand Hills Ordovician
54. Ella Waddell
55. Waddell
56. Jordan
57. Penwell
58. Douro
59. Harper
60. South Cowden
61. Foster
62. Johnson
63. North Cowden and North Cowden Deep
64. Goldsmith
65. North Goldsmith
66. West Andrews
67. Emma
68. Fuhrman
69. Parker
70. Deep Rock
71. Means
72. Cedar Lake
73. Seminole
74. Wasson
Wasson Deep
Wasson 72
75. West
76. Waples Platter
77. Dean
78. Slaughter
79. Grassroots
80. Carter
81. Moore
82. Howard-Glasscock
83. Snyder
84. Iatan-East Howard
85. Westbrook
86. Sharon Ridge
87. Funk
88. Irion
89. Opp
90. Page
*91. Lubbock
*92. Garza
*93. Ownby
*94. Heiner
*95. Bean
*96. Wentz
*97. Barnhart
*98. Weiner
*99. Spencer
*100. Clara Couch
101. Anthony
102. Dobbs
103. Simpson
104. Hoover
105. Shearer
*106. Fuhrman West
*107. Welch

* 1941 discovery.

New Mexico Fields

1. High Lonesome
2. Red Lake
3. Dayton
4. McMillan
5. Artesia
6. Loco Hills
7. Leonard
8. Grayburg
9. Jackson
10. Robinson
11. Shugart
12. Getty
13. Barber
14. PCA
15. Maljamar
16. Halfway
17. Vacuum
18. South Lovington
19. Hobbs
20. Monument
21. Lynch
22. West Eunice
23. Eunice
24. South Eunice
25. Arrowhead
26. Skaggs
27. Caprock
28. Hardy
29. Penrose
30. Skelly
31. Lynn
32. Cooper
33. Mattix
34. Langlie
35. Jal
36. Eaves
37. Rhodes
*38. Salt Lake

* 1941 discovery.

Important Wells

West Texas

1-A Humble Oil and Refining Company's Byrd No. 1
1-B Humble Oil and Refining Company's Matador No. 1-D
1-C Humble Oil and Refining Company's Matador No. 1-C
1-D Humble Oil and Refining Company's Elwood No. 1
1-E Magnolia Petroleum Company's Walton No. 20
1-F Gulf Oil Corporation's University No. 1-F
1-G Wiggins and Hyde's Stimson and Burley No. 1
1-H Redmond and Greene's Iowa Realty and Trust Company No. 1
1-I Callahan and Wagner's Wahlenmier No. 1
1-J Broderick and Calvert *et al.* Haywood No. 1
1-K Phillips Petroleum Company's University-Andrews No. 1
1-L Livermore Drilling Company's Rice No. 1
1-M Magnolia Petroleum Company's Teague No. 1
**1-N Pure Oil Company's Frazier No. 1-A
1-O Atlantic Refining Company's Boyd No. 21
1-P Continental Oil Company's Jones No. 1
1-Q Gulf Oil Corporation's Tubb No. 1-B
1-R Gulf Oil Corporation's Waddell No. 17
1-S Gulf Oil Corporation's Waddell No. 1-A
1-T Stanolind Oil and Gas Company's Conry-Davis No. 1
1-U Amerada Petroleum Company's Todd No. 1-C
1-V Cain and Dunn's Downs No. 1

** Wells numbered 1-N to 1-V inclusive, are producers.

New Mexico

A. Fullerton Oil Company's State No. 1
B. Marshall and Uscan's Cunningham No. 1
C. Brown's State No. 1
D. Richmond Drilling Company's Shell-State No. 1
E. Carl B. King Drilling Company's State No. 1
F. Helmerich and Payne's State No. 1
G. Elliott's State No. 1
H. Sudderth *et al.* Wills No. 1
I. Sanders Brothers' Leonard No. 1
J. Ney Hightower's Grier No. 1
K. Plains Production's Jones No. 1

Important Drilling Wells in West Texas

2-A Fullerton Oil Company's Wilson No. 1
2-B Shell Oil Company's Sealy-Smith No. 1
2-C Plymouth Oil Company's Alford No. 1
2-D Moncrief and Helmerich and Payne's Couch No. 1
2-E Phillips Petroleum Company's University No. 1-A
2-F Moore Brothers' Halff No. 2-C

The map of West Texas and New Mexico is brought up to date from last year's development report. It is from the base map of Robert Muldrow, III.

SOUTHEASTERN NEW MEXICO OPERATIONS

	1937	1938	1939	1940	1941
Total wells drilled	666	559	648	542	371
Number of field producers	617	481	563	468	332
Number of wildcats	43	66	62	22	39
Per cent wildcat successes	13.9	37.9	45.1	13.5	10
Pipe-line runs (millions of barrels)	37.95	35.26	36.97	38.48	39.34

The reasons for the increased activity are: (1) a sustained discovery rate in the preceding years; (2) several large semi-proved and proved undeveloped areas; (3) encouraging aspects of deeper Permian and pre-Permian production; (4) improved economic factors such as pipe-line outlet and increased crude prices. In New Mexico, despite the wildcat successes of recent years the areas opened were not large and hazards resulting from lenticularity of sands and oil zones have caused a diminished rate of development.

In West Texas, nine of the wildcats successfully completed as producers opened new areas for future development: (1) Andrews County, West Fuhrman pool, (2) Cochran County, Rhodes pool; (3) Crockett County, Bean pool and (4) Clara Couch pool; (5) Lubbock County, Lubbock pool; (6) Reagan County, Barnhart pool; (7) Ward County, Spencer pool; (8) Winkler County, Weiner pool; (9) Yoakum County, Ownby pool. In addition to these, three new areas found additional pay levels: Wasson, Abell and White, and Baker. At the close of the year, two new areas in Andrews and Dawson counties were in the process of being opened but had not been officially gauged.

Statistically the wildcat success factor was the lowest of the years tabulated but many of the pre-Permian wells, although not included as wildcats (arbitrarily, wells more than a mile distant from a producer), would be rightly considered so because of complex and unknown subsurface conditions.

An improved economic condition stimulated development and sustained exploration. The combined price increases, amounting to 17 cents per barrel of crude, as shown in the price schedule,[3] constituted the first appreciable rise since 1938.

Date	*Gravity*	*Price*
January, 1938	20°	$0.78
	40° and above	1.08
October 11, 1938	Below 20°	0.55
	40° and above	0.95
March 29, 1941	Below 20°	0.62
	40° and above	1.02
May 21, 1941	Below 20°	0.72
	40° and above	1.12

Another contributing factor to the favorable development of large areas were the construction of 222 miles of feeder pipe lines (excluding

[3] Only the upper and lower limits of the gravity scale are shown.

the gathering lines laid within the fields) and the increases made in the capacities of the main trunk lines out of the region by pump installations, looping of lines, and larger pipe. The capacity of the main trunk lines of the region is now approximately 440,000 barrels of crude per day.

Geological developments during 1941 included the publication of many papers. There were stratigraphic papers on the Mississippian of the Sacramento Mountains,[4] on the interrelation of Permian paleontologic and stratigraphic facies,[5] on San Andres problem,[6] on the Tansill formation,[7] on Cretaceous and Tertiary rocks in the Davis Mountains,[8] and on the Quaternary dune sands[9] in the vicinity of Monahans, Texas, and a continuation of the discussion of Permian nomenclature.[10] In two paleontologic papers Permian fossils were described from deep underground in Hockley County,[11] and from a thin dolomite member in the redbed outcrops of Briscoe County,[12] Texas. In six papers exploratory geology and the occurrence of oil and gas were discussed in the following localities: the Shipley-Silurian field,[13] the North Cowden field,[14] the Page field,[15] the Wasson field,[16] the "Sand

[4] L. R. Laudon and A. L. Bowsher, "Mississippian Formations of Sacramento Mountains, New Mexico," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 12 (December, 1941), pp. 2107–60.

[5] Carl O. Dunbar, "Permian Faunas: A Study in Facies," *Bull. Geol. Soc. America*, Vol. 52, No. 3 (March 1, 1941), pp. 313–32.

[6] Frank E. Lewis, "Position of San Andres Group, West Texas and New Mexico," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 1 (January, 1941), pp. 73–103.

[7] Ronald K. DeFord and George D. Riggs, "Tansill Formation, West Texas and Southeastern New Mexico," *ibid.*, Vol. 25, No. 9 (September, 1941), pp. 1713–28.

[8] Ronald L. Ives, "The Mitre Peak Area, Trans-Pecos Texas," *Amer. Jour. Sci.*, Vol. 239, No. 5 (May, 1941), pp. 339–53.

[9] Roy M. Huffington and Claude C. Albritton, Jr., "Quaternary Sands on the Southern High Plains of Western Texas," *Amer. Jour. Sci.*, Vol. 239, No. 5 (May, 1941), pp. 325–38.

[10] H. G. Schenck *et al.*, Hollis D. Hedberg, C. W. Tomlinson, J. E. Eaton, and R. T. White, "Stratigraphic Nomenclature," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 12 December, 1941), pp. 2195–2211.

[11] Merrill A. Stainbrook and Ruford F. Madera, "A Deep Subsurface Permian Fauna from Hockley County, Texas," *Jour. Paleon.*, Vol. 15, No. 4 (July, 1941), pp. 376–83.

[12] Robert Roth, Norman D. Newell, and Benjamin H. Burma, "Permian Pelecypods n the Lower Quartermaster Formation, Texas," *Jour. Paleon.*, Vol. 15, No. 3 (May, 1941), pp. 312–17.

[13] C. D. Cordry and M. E. Upson, "Silurian Production, Shipley Field, Ward County, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 3 (March, 1941), pp. 425–27.

[14] Sam C. Giesey and Frank F. Fulk," North Cowden Field, Ector County, Texas," *i bid.*, Vol. 25, No. 4 (April, 1941), pp. 593–629.

[15] Roscoe Simpson, "Page Field, Schleicher County, Texas," *ibid.*, Vol. 25, No. 4, pp. 630–36.

[16] Alden S. Donnelly, "High-Pressure Yates Sand Gas Problem, East Wasson Field, Yoakum County, West Texas," *ibid.*, Vol. 25, No. 10 (October, 1941), pp. 1880–97.

Belt" fields,[17] and the developed[18] and undeveloped[19] parts of the whole West Texas-Southeastern New Mexico province. The North Cowden and Wasson papers also took up petroleum engineering problems. Miscellaneous papers and geologic notes contained discussions of the application of insoluble residue[20] and radioactive well-logging methods[21] in West Texas, the subsurface occurrence of sodium sulphate[22] in New Mexico, and solution effects[23] on limestone outcrops in trans-Pecos Texas. Papers on adjacent areas and correlative rocks and their contained fossils are listed in a footnote[24] for reference.

The West Texas Geological Society conducted two field trips[25] in 1941. At the annual meeting of the Association in Houston, April

[17] R. L. Denham and W. E. Dougherty, " 'Sand Belt' Area of Ward and Winkler Counties, Texas, and Lea County, New Mexico," in *Stratigraphic Type Oil Fields* (Amer. Assoc. Petrol. Geol., 1941), pp. 750–59.

[18] Taylor Cole, Robert I. Dickey, and Edgar Kraus, "Developments in West Texas and Southeastern New Mexico during 1940," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 6 (June, 1941), pp. 1044–63.

[19] West Texas Geological Society, "Possible Future Oil Provinces of West Texas," *ibid.*, Vol. 25, No. 8 (August, 1941), pp. 1527–38.

[20] Taylor Cole, "Midland, Texas, Insoluble Residue Study Group," *ibid.*, Vol. 25, No. 2 (February, 1941), p. 318.

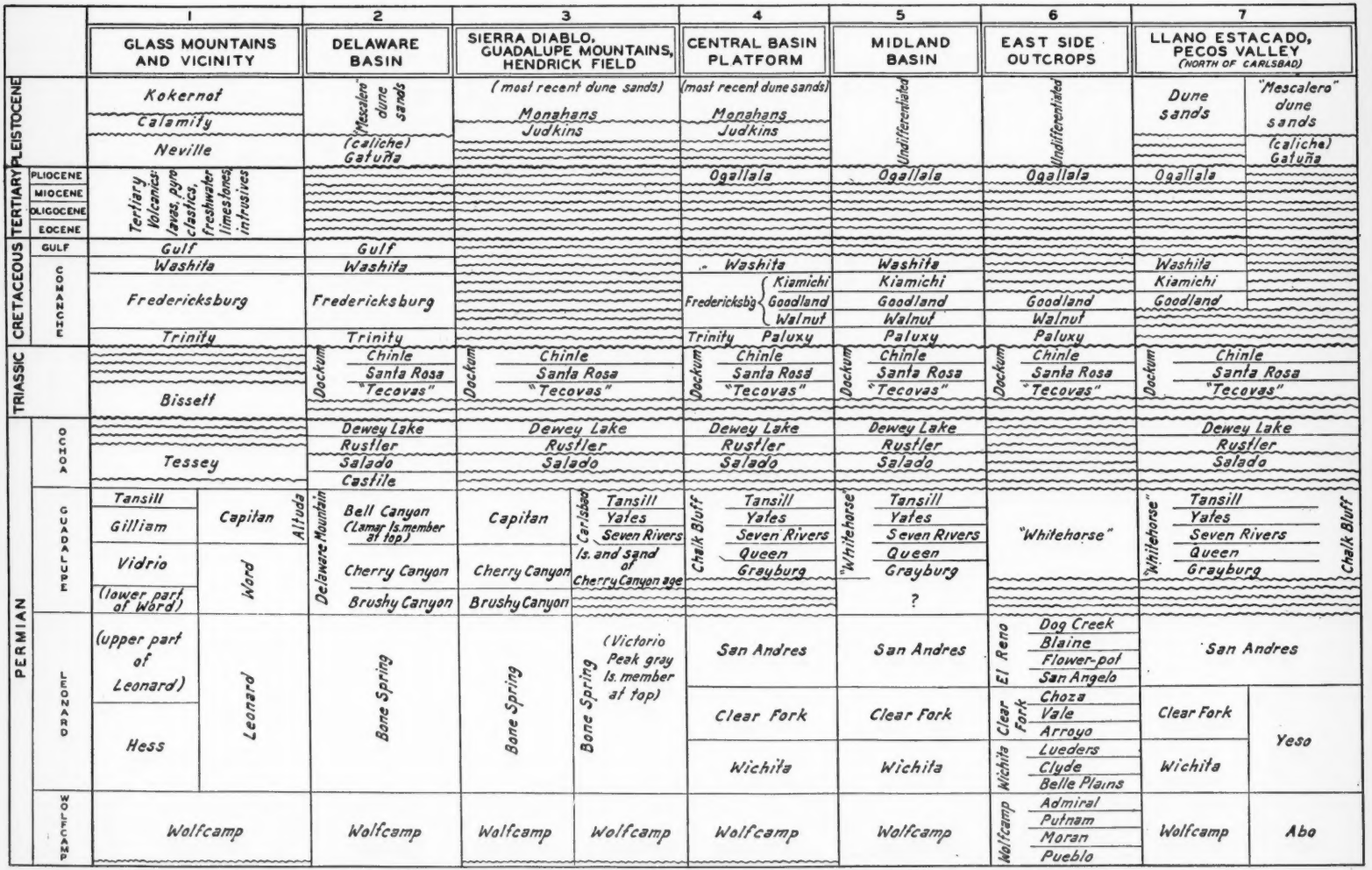
[21] William L. Russell, "Well Logging by Radioactivity," *ibid.*, Vol. 25, No. 9 (September, 1941), pp. 1785–86; No. 12 (December, 1941), p. 2211.

[22] Walter B. Lang, "New Source for Sodium Sulphate in New Mexico," *ibid.*, Vol. 25, No. 1 (January, 1941), pp. 152–60.

[23] J. Fred Smith, Jr., and Claude C. Albritton, Jr., "Solution Effects on Limestone as a Function of Slope," *Bull. Geol. Soc. America*, Vol. 52, No. 1 (January 1, 1941), pp. 61–78.

[24] A. I. Levorsen, "Ellenburger Structure Map of Central Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 8 (August, 1941), pp. 1598–1600.
Samuel S. Goldich, "Evolution of the Central Texas Granites," *Jour. Geol.*, Vol. 49, No. 7 (October–November, 1941), pp. 697–720.
G. E. Anderson, "Origin of Line of Color Change in Red Bed Deposition," *Bull. Geol. Soc. America*, Vol. 52, No. 2 (February 1, 1941), pp. 211–18.
Louis L. Ray and J. Fred Smith, Jr., "Geology of the Moreno Valley, New Mexico," *ibid.*, pp. 177–210.
Charles S. Denny, "Quaternary Geology of the San Acacia Area, New Mexico," *Jour. Geol.*, Vol. 49, No. 3 (April–May, 1941), pp. 225–60.
William E. Powers, "Volcanic Rocks of the Western San Augustin Plains District, New Mexico," *ibid.*, Vol. 49, No. 2 (February–March, 1941), pp. 207–17.
A. S. Romer and L. W. Price, "Review of the Pelycosauria," *Geol. Soc. America Spec. Paper 28*, pp. 1–538.
A. S. Romer and R. V. Witter, "The Skin of the Rhachitomous Amphibian *Eryops*," *Amer. Jour. Sci.*, Vol. 239, No. 11 (November, 1941), pp. 822–24.
E. C. Olson, "New Specimens of Permian Vertebrates in Walker Museum," *Jour. Geol.*, Vol. 49, No. 7 (October–November, 1941), pp. 753–63.
J. Brookes Knight, "Paleozoic Gastropod Genotypes," *Geol. Soc. America Spec. Paper 32*, pp. 1–510.

[25] "Spring Field Trip. Fort Worth to Midland, Texas. On Highway 80—Along the T. & P.," *West Texas Geol. Soc.* (May 10–11, 1941), pp. 1–69; supplement, pp. 1–21.
"Fall Field Trip. Big Bend Park Area. Brewster County, Texas," *ibid.* (September 27–28, 1941), pp. 1–50.



Correlation chart, Permian and post-Permian rocks, West Texas and southeastern New Mexico, by Ronald K. DeFord.

2–4, 1941, the society exhibited its large cross section[26] that extends from north-central Texas through West Texas to trans-Pecos Texas.

Geological developments during 1941 included progress in correlation and nomenclature. The following is a tabulation of pre-Permian rocks recognized at present in the subsurface of West Texas. An asterisk indicates that the rocks so marked produced oil during 1941.

*Permian system
Unconformity and Overlap
Pennsylvanian system
Cisco series
Canyon series
*Strawn series
Bend group
Unconformity and Overlap
Mississippian system
Chester series
Devonian system
Silurian system
*Niagaran series
Disconformity
Ordovician system
Montoya formation
Disconformity
*Simpson group
*McKee sand†
*Waddell sand†
*Ellenburger group (upper part)
Cambrian system
*Ellenburger group (lower part)
*Unnamed conglomeratic sandstone
Unconformity and Overlap
Pre-Cambrian systems

† The McKee and Waddell sands are productive sandstone members within the Simpson group. Taylor Cole, C. D. Cordry, and H. A. Hemphill, "McKee and Waddell Sands, Simpson Group, West Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 26, No. 2 (February, 1942), pp. 279–82.

A revised correlation of Permian and post-Permian rocks is shown in the accompanying chart.

Wolfcamp series.—In the east-side outcrops (column 6) the base and top of Wolfcamp are chosen, and correspondingly the Pueblo and Admiral formations are defined, according to M. G. Cheney.[27]

Leonard series.—The definition of Wichita (restricted), which is the most practical definition for West Texas and the Panhandle, is clearly indicated by the chart.

The San Andres problem may be stated thus: is the San Andres Leonard or Guadalupe, or partly both? Despite the chart, the problem has not yet been solved.

Guadalupe series.—The Vidrio has often been described and shown in correlation charts as equivalent to the Capitan. Frank E. Lewis,[28] however, pointed out that Word grades into Vidrio. As a result of conferences between Lewis, Philip B. King, and others, the massive Capitan-like limestone of Word age is called Vidrio, whereas the overlying massive limestone, younger than Word but older than Tessey, is called Capitan.

[26] "Stratigraphic Cross Section, West Texas Permian Basin," *ibid.* Horizontal scale, 10,560 feet = 1 inch; vertical scale, 1,000 feet = 1 inch; overall length, 19 feet.

[27] M. G. Cheney, "Geology of North-Central Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 1 (January, 1940), pp. 65–110.

[28] *Op. cit.*, pp. 81–82.

The Capitan of the Glass Mountains grades basinward into Altuda, and lagoonward into thin-bedded Gilliam limestone. The top of the Gilliam coincides with the top of a sandstone member and is probably the same horizon as the top of the Yates. The overlying thin-bedded limestones beneath the massive, almost unbedded Tessey have the appearance of Tansill.

The Ocotillo silt member[29] of the Tansill formation, not shown on the chart, can be readily identified in the area represented by column 3.

Whether the Queen formation is of Capitan or Cherry Canyon age (in other words, whether or not the Queen is part of the Carlsbad) is not settled.

The quotation marks on the term "Whitehorse" signify that two points are still under debate: (1) the exact stratigraphic range of the typical Whitehorse of Oklahoma; (2) the proper correlation between Oklahoma and West Texas.

The question mark beneath Grayburg in column 5 suggests doubt as to the presence or absence of older Guadalupe beds in the Midland basin.

The Yoakum dolomite, not shown on the chart, is a member of the Queen formation. In the subsurface of Yoakum and Gaines counties, Texas, and elsewhere under the Llano Estacado, it is commonly but unfortunately referred to as the "brown lime." There are at least a half dozen "brown limes" in West Texas and southeastern New Mexico occurring at different horizons in a vertical range of 1,500 feet or more.

Ochoa series.—The precise correlation of Tessey with Castile and (or) Salado and Rustler is not yet established.

The Cowden anhydrite,[30] not shown on the chart, is a member of the Salado formation and is as widespread as the formation itself.

Some geologists believe that representatives of the Ochoa series are present in the east side outcrops (column 6). Their presence or absence is not yet proved.

Triassic system.—The quotation marks on "Tecovas" signify that certain geologists claim that the word is misused on this chart. According to their interpretation the typical Tecovas of the Texas Panhandle is not older than Santa Rosa.

Jurassic system.—The absence of Jurassic beds is noteworthy.

Tertiary system.—The Tertiary rocks shown in column 1 crop out in the Davis Mountains west and northwest of the Glass Mountains.

Over wide areas the Pliocene Ogallala formation is capped by

[29] DeFord and Riggs, *op. cit.*, pp. 1717, 1722.

[30] Giesey and Fulk, *op. cit.*, p. 603.

caliche, which is probably older than the caliche that caps the Pleistocene Gatuña formation.

Although not shown in column 2, a small remnant of Ogallala is present in the extreme northern part of the Delaware basin.

Quaternary rocks.—The sequence Neville, Calamity, Kokernot (column 1) is exposed in the Davis Mountains. It was described and defined by Bryan and Albritton[31] in 1939. In 1941, Huffington and Albritton[32] defined the Monahans and Judkins formations near Monahans, Texas, on the Central Basin platform (columns 3 and 4), and suggested a correlation with the section exposed in the Davis Mountains, to wit, that the Judkins was deposited during the Neville-Calamity hiatus and the main body of the Monahans during the Calamity-Kokernot hiatus. It is suggested herein that the Judkins is younger than the Gatuña[33] formation of the Pecos Valley (columns 2 and 7).

Melton[34] recognized three ages of dune sand in the Llano Estacado. To call attention to this three-fold division columns 3 and 4 show "most recent dune sands" as younger than Monahans, although Huffington and Albritton included these very recent deposits as the "upper part"[35] of the Monahans formation.

DEVELOPMENTS IN PERMIAN OF WEST TEXAS, 1941

A preponderance of exploratory drilling in West Texas during recent years has been chiefly concerned in locating favorable structural and stratigraphic traps along the edges of the established Central Basin platform and in extending it northward. This process was continued during 1941. However, the discovery, during 1940 and early 1941, of deeper Permian reservoirs some distance inside the lateral limits of the platform has induced many operators to test below the upper producing zones of the nearest field.

NEW PERMIAN PAY ZONES

Three new Permian pay zones were revealed in 1941 with the possibility of a fourth after additional testing early in 1942. It is signifi-

[31] C. C. Albritton, Jr., and Kirk Bryan, "Quaternary Stratigraphy in the Davis Mountains, Trans-Pecos Texas," *Bull. Geol. Soc. America*, Vol. 50, No. 9 (September, 1939), pp. 1423–74.

[32] *Op. cit.*

[33] Walter B. Lang, "Geology of the Pecos River between Laguna Grande de la Sal and Pierce Canyon," *12th and 13th Biennial Reports of the State Engineer of New Mexico* (1938), pp. 84–85.

[34] Frank A. Melton, "A Tentative Classification of Sand Dunes. Its Application to Dune History in the Southern High Plains," *Jour. Geol.*, Vol. 48, No. 2 (February–March, 1940), pp. 136–73.

[35] *Op. cit.* Table 2, p. 337.

cant that all of these zones discovered during the year were in the Yeso-Clear Fork group of the Permian. Some difference of opinion exists on the correlations of the producing zones within the Yeso-Clear Fork owing to: distances between the fields, sparse and scattered control, facies changes. It is possible that additional information will show fields now considered as producing from different pay zones to be equivalent.

Probably the most significant discovery well in the north part of the district was L. C. Harrison *et al.* Nairn No. 1 in Lubbock County. As a result of this discovery and the 1940 discovery of Clear Fork oil in the Wasson field many of the wildcats drilled in the north basin area have had the Yeso-Clear Fork group as an objective, as well as the San Andres. Seventeen such tests were drilled north of the Andrews-Gaines County line.

The Lubbock pool well is in Sec. 25, Block A, John H. Gibson Survey, $3\frac{1}{2}$ miles east-northeast of the city of Lubbock. Much of its importance lies in the large area of possible production. The Garza field in Garza County is 42 miles south and the Slaughter field in Hockley County is 39 miles west.

Unfortunately, the upper-hole rotary samples were not collected and the quality of those collected from below allows some question to arise about the true nature of the section drilled. Samples from the second test have not been released. A tentative correlation follows.

	Depth in Feet
Cretaceous ?	No samples saved above
Triassic	1,500 feet
Permian	
Ochoa series	?–1,880
Top of anhydrite	1,570
Whitehorse group	1,880–3,100
Top of Yates sand	1,920 (?)
San Andres group	3,100–4,600
Clear Fork group	4,600–5,002 (total depth)
Lubbock pay zone	4,870–5,002 (broken)

The first showing of oil was encountered at a depth of 4,870 feet after a drill-stem test of the San Andres beds showed only drilling mud. The intermittently finely granular and finely porous dolomite from 4,870 to total depth yielded 160 barrels of 28° gravity oil per day plus 5 per cent water when pumped on initial potential test. An attempt to extend the field northwest by Harrison's Steck No. 1, 2 miles north of Lubbock, in Sec. 7, Block A, J. H. Gibson Survey, was unsuccessful after drilling to 5,510 feet. The well was abandoned after no showings of oil were reported. Geological information about the well has not been released. Considerable leasing activity followed the drilling of the discovery and several tests are proposed for the early part of 1942.

A third and new producing zone in the Wasson field resulted from the testing in 1941 of the deep test commenced in the latter part of 1940 and drilled to 11,108 feet. A. G. Carter's Wasson No. 4-D, Sec. 50, Block AX, P. S. L. Survey, was completed, flowing by gas lift at an initial potential gauge of 511 barrels of 34° gravity oil per day through ½-inch choke. Prior to completion the hole had been plugged back to 7,433; the top of the productive zone was reported as 7,055 feet. Though geological information has not been released about either of the two lower producing zones it is rather certain that this new zone, "Wasson 72," lies some distance stratigraphically below the "Wasson Deep" producing zone which occurs from 6,300 to 6,881 feet. The two deep discovery wells are 1,800 feet apart. Estimates place the new zone in the lower Clear Fork or upper Wichita.

The possibilities of deeper production from new zones on the Central Basin platform were increased at the close of the year by reports of oil-stained cores plus flows of gas and oil during drill-stem tests from the Fullerton Oil Company's H. M. Wilson No. 1, 9 miles northwest of Shafter Lake, in Sec. 15, Block A–32, P. S. L., Andrews County. The depth of the potentially productive zone is from 6,790 to 7,400 feet in a porous granular dolomite. Geological information has not been released but the depths suggest Leonard age. This zone may be equivalent to the "Wasson 72."

NEW AREAS OF ESTABLISHED PAY ZONES IN PERMIAN

1. *Upper Delaware Mountain, Yates sand, and Seven Rivers.*—In the southwestern part of the Delaware basin, a significant test that appeared to be the discovery of a new pool was the Pure Oil Company's G. C. Frazier No. 1-A, 21 miles west of Fort Stockton in Sec. 31, Block 49, T. 10, Texas and Pacific R. R. Survey, Pecos County. The well filled with a fluid, most of which was reported to be oil, at a depth of 5,100 feet. The source of the oil is the upper part of the Delaware Mountain sand, topped at 5,082 feet. No tests were made when the oil was encountered but drilling was continued to the contract depth of 6,000 feet. At 5,370 feet, bottom-hole water was definitely encountered. A log of the test indicates the following geological markers.

	Depth in Feet
Cretaceous	0– 488
Triassic and Permian redbeds	488–1,042
Permian	
Rustler	1,042–1,460
Salado	1,460–3,550
Castile	3,550–5,055
Delaware Mountain	5,055–6,001 (total depth)
Lamar limestone	5,055–5,082
Delaware Mountain sand	5,082–6,001

Another Delaware basin test, the K. Slack *et al.* Pat Wilson No. 1,

failed to extend the 1940 discovery—the Hayes gas field—in Ward County near the railroad siding of Quito. This well is approximately 1 mile south of the discovery and in Sec. 145, Block 34, H. & T. C. Survey. Oil and water were found in the Delaware Mountain sand, topped at 5,023 feet, or structurally 39 feet lower than in the discovery well. The Delaware Mountain black limestone was found at 4,995 feet. On potential test the well flowed 24 barrels of 42° gravity oil and 10 barrels of water per day with 150,000 cubic feet of gas but later the well was abandoned as non-commercial.

The only discovery from the Yates sand in West Texas was a small gas well completed as H. L. Cain and S. G. Dunn's Sun-M. J. Downs No. 1, Sec. 8, Block 105, H. & G. N. Survey, Pecos County, ½ mile north of the Grassroots field. This well produced 960,000 cubic feet of gas from casing perforations made from 1,400 to 1,507 feet. At the close of the year this was the only producer and it was shut in. The well is located on the apex of a northwest-trending anticline as defined by previously drilled dry holes. The stratigraphic section follows.

	Depth in Feet
Cretaceous	0– 260
Triassic	260– 460
Permian	
Dewey Lake	460– 650
Rustler	650– 860
Salado	860–1,305
Tansill	1,305–1,400
Yates sand	1,400–1,583 (total depth)

A new reef pool, the Spencer pool, on the western edge of the Central Basin platform on the same trend as the Magnolia-Sealy and Magnolia-Sealy South pools, was discovered by the Stanolind Oil and Gas Company's Molly Edna Spencer No. 1, Sec. 53, Block 34, H. & T. C. Survey. This well was completed, with natural initial flow of 226 barrels of 26° gravity oil and 217 barrels of water through ¼-inch choke on 2-inch tubing. The top of the "pay" is at 2,925 feet in the upper part of the Seven Rivers formation and the well was drilled to 2,990 feet. It was completed, June 28, 1941. Subsequent wells have been as large, or larger, with no water where only 1 or 2 feet of the pisolitic and oölitic "pay" was drilled. At the end of the year there were four producers, one dry hole, and one drilling well in the pool.

The following stratigraphic section is found in the discovery well.

	Depth in Feet
Surface, Triassic and Permian redbeds (undifferentiated)	0–1,800
Permian	
Rustler	1,800–2,110
Salado	2,110–2,570
Tansill	2,570–2,690
Yates sand	2,690–2,850
Seven Rivers	2,850–2,990 (total depth)

The Noelke pool in Crockett County, producing from the upper Seven Rivers and discovered in 1940, was very active during 1941. With the exception of the northwest extensions, all of the tests were unsuccessful—resulting in the field being defined by dry holes on the east, south, and west. Three gas wells were completed on the western limits of the field and a 1½-mile northwest extension, drilled as the Wilshire Oil Company's George Thompson No. 1, Sec. 58, Block BB, Ingham Survey, was completed at the total depth of 1,285 feet. The extension had an initial potential of 476 barrels of oil for 12 hours as established by a 1-hour test of 39 barrels through 2-inch tubing. The following formational markers show it to be approximately 200 feet lower than the discovery well: top of Salado salt, 715 feet; top of Yates sand, 1,068 feet; top of Soma sand, 1,256 feet. Wilshire's No. 2, a west offset to No. 1, was dry in the pay sand and was abandoned at 1,712 feet. Subsequently the M. & M. Drilling Company's Bouscaren No. 1, midway between the extension and the field, was completed as a 40 million cubic foot gas well.

2. *Queen formation.*—Activity in the dormant "Sand Belt" area on the west side of the Central Basin platform was revived by the discovery of the Weiner pool in Winkler County, one mile east of the Emperor pool, by Sam Weiner's S. B. Halley No. 1, Sec. 7, Block B-11. The formations penetrated were found as follows: top of anhydrite, 770 feet (+2,027); top of Tansill, 2,250 feet (+547); top of Yates sand, 2,318 feet (+479); top of Colby sand, 3,005 feet (−208). The pay sand produces farther north in Winkler County, in the Keystone pool, and is stratigraphically lower than the productive reef dolomites and sands west of it. After the bore was shot with 460 quarts of nitroglycerine from 3,005 to 3,205 feet the well flowed at the rate of 370 barrels of 33.5° gravity oil per day through ¾-inch choke on 2½-inch tubing.

Activity around the flanks of the Taylor-Link field in Pecos County was revived with the discovery of oil by Milton Unger's Shell-University well No. 1, ¾ mile east of the Taylor-Link field, in Sec. 33, Block 16, U.L. Survey. The well flowed 264 barrels of 30° gravity oil in 24 hours, after a 50-quart shot, from sand encountered from 1,445 to 1,470 feet. The sand is the same as that which produces in the Walker pool 3½ miles east. The reservoir is a stratigraphic trap which pinches out updip on the Taylor-Link structure.

3. *Grayburg formation.*—No important discoveries were made during the year in the Grayburg formation, but several noteworthy extensions were drilled. In Upton County, the McElroy area was extended by George E. Farley's M. G. Domron No. 1 Sec. 192, Block F, C.C.S.D. & R.G.N.G. R.R. Survey, 1½ miles east of the Eddleman

extension of 1940, and ¼ mile south of an old dry hole—the Humble Oil and Refining Company's M. G. Domron No. 1. Oil was found in the "McElroy lime," Grayburg in age, at 3,185 feet. After the well was shot with 750 quarts of nitroglycerine from 3,040 to 3,200 feet, a potential of 138 barrels of 30° gravity oil and 10 per cent water was pumped.

Another pumper wedged between dry holes, and ½ mile south of the Eddleman extension, possibly portends the linking of the McElroy pool with the McCamey area on the south. The Texas Pacific Coal and Oil Company's Lydia Elgoff No. 1, Sec. 5, John H. Gibson Survey, produced 242 barrels of 32° gravity oil by pumping. The oil comes from 150 to 450 feet below the top of the "McElroy lime," reached at 2,803 feet. Other markers logged were: top of anhydrite, 1,100 feet (+1,770); top of Yates sand, 2,260 feet (+560).

In Ector County, in contrast to the results of the past few years, no new discoveries were made in 1941. The Addis-Foster-Johnson-South Cowden group of pools producing mainly from the Grayburg was extended more than a mile northeast by the Sinclair Prairie Oil Company's Palmer No. 1. Initial potential test yielded 2,808 barrels of flowing oil. This area was also extended southward by the Forest Development Company's Henderson No. 1 and B. Edwards No. 1. Subsequently, 8 dry holes around the field further defined it.

Three important tests were drilled in that part of the Midland basin covered by Andrews and Martin counties. The first, the Texas and Pacific and Seaboard Oil Company's Midland Farms Inc. No. 1-C, was drilled in Sec. 8, Block 41, T. 1 N., T. & P. Survey, as a result of showings in the Texas Pacific Oil Company's Midland Farms No. 1-A, drilled in 1940. The No. 1-C was low relative to the 1-A on the following markers: top of anhydrite, 1,940 feet (+1,061); top of Yates sand, 3,110 feet (−9); top of Grayburg, 4,630 feet (−1,629). Circulation of rotary mud was lost between 4,824 and 4,828 feet in porous dolomite. A core from 4,934 feet to the total depth of 4,955 showed only a small amount of fine porosity which bled oil and sulphur water. The second important basin well was Wiggins and Hyde's Stimson and Burley No. 1, Sec. 4, Block 38, T.1 S., T. & P. R.R. Survey, Martin County, drilled on the basis of surface mapping. It logged only slight showings of gas in the Grayburg and San Andres and was abandoned at 5,002 feet. Stratigraphic markers were: top of anhydrite, 1,870 feet (+1,018); top of Yates sand, 2,800 feet (+38); top of Grayburg, 4,190 feet (−1,352); top of San Andres, 4,450 feet (−1,612). Some geologists believe that this well did not reach the San Andres.

The third important basin test in the central Midland Basin area was the Magnolia Petroleum Corporation's N. B. Teague No. 1, in

Labor 10, League 260, Borden County School Land, Martin County. This test was noteworthy not only because of the few wells drilled in this part of the basin but because of its greater stratigraphic penetration by drilling to 7,701 feet. Several interpretations regarding the equivalency of platform and basin-type sections exist; the following marker depths are given as one: top of anhydrite, 1,930 feet (+1,001); top of Yates sand, 2,760 feet (+171); top of Grayburg, 4,290 feet (−1,359); top of San Andres, 4,600 feet (−1,669); top of Clear Fork, 6,090 feet (−3,159). The upper part of San Andres at this point was found to be composed of sandy dolomite while the lower part is predominantly sand. The Clear Fork consists of shaly limestones and dark shales.

4. *San Andres formation.*—Five new localities producing from the San Andres were discovered during the year—a sixth was drilled and tested but the official potential test was not made until January 9, 1942. Two of the discoveries were in the north basin area, one in the central basin area, and the remaining three in the southern part of the basin.

A. *Upper San Andres pay zone.*—A very small area of production southeast of the Todd field in Crockett County, the Bean pool, was opened by E. H. Wahlenmaier and Steve Curries' George Bean No. 1, Sec. 48, Block UV, G.C. & S.F. Survey. This well flowed 196 barrels of 26° gravity oil on gas lift with 5 per cent water on initial test. The top of the "pay" was reached at 1,451 feet and the well was drilled to 1,456 feet. The same operators' well No. 2, 1,600 feet northeast of the discovery, was a dry hole. The following stratigraphic section is taken from the discovery well.

	Depth in Feet
Cretaceous	0–700
Permian	
Yates sand	700– 800
Seven Rivers	800– 998
Queen	998–1,130
Grayburg	1,130–1,370
San Andres	1,370–1,456 (total depth)

An important area of shallow production, the Clara Couch pool, the only discovery of the year producing from the Penn-Goldsmith zone, was opened in southwestern Crockett County by Inman and Harris' (formerly R. H. Henderson *et al.*) Mrs. Clara Couch No. 1, Sec. 37, Block GG, H.E. & W.T. Survey. The well was completed, September 9, 1941, at 2,186 feet and flowed 88 barrels of 25.5° gravity oil in 6 hours through 2-inch tubing. The top of the "pay" was at 2,166 feet and the well was treated with 3,000 gallons of acid. A second well (Humble's J.W. Owens No. 1), a 1½-mile northwest extension, pumped 109 barrels of oil on initial test in 24 hours after an acid treatment of

7,000 gallons. At the end of the year there were two producers and three locations staked in the pool. The following stratigraphic section was logged in the discovery well.

	Depth in Feet
Cretaceous	0– 635
Triassic	635– 914
Permian	
Ochoa series	914–1,206
Whitehorse group	1,206–2,157
Top of Grayburg	1,914
San Andres group	2,157–2,186 (total depth)
Pay zone	2,166–2,186

The Abell field in Pecos County, which had more new "pays" discovered in 1941 than any other field in West Texas, had two areas of Penn-Goldsmith zone production established. One area was discovered by The Texas Company's O. W. Williams No. 1, Sec. 15, Block 2, H. & T.C. Survey, which made 344 barrels of 37° gravity oil in 24 hours through gun-perforated casing at a plugged-back depth of 2,310 feet after acid treatment. The other area in the Abell field was discovered by the Magnolia's State-Myrick No. 1-B, Sec. 31, Block 9, H. & G.N. Survey, which reached the Yates sand at 1,120 feet (+1,259) and the San Andres at 2,200 feet (+177).

B. *Cedar Lake pay zone.*—In the Cedar Lake area two wildcats, drilled in an effort to extend the Cedar Lake pool, were failures. The first, the San Andres Producing Company's J. C. Johnson No. 1-A, was located one mile south of the field in Sec. 6, Block C-30, P.S.L. Survey, Gaines County. Only slight oil stains were found and the well was abandoned at 5,000 feet. It was found to be 150 feet lower structurally than producers on the north. The second wildcat was in Dawson County, approximately $3\frac{1}{2}$ miles northeast of the field in Sec. 87, Block M, E.L. R.R. Survey. The Stanolind Oil and Gas Company's Scanlon No. 2 was structurally higher on the top of the San Andres than the field wells but the quality and amount of porosity were insufficient; cores showed only pin-point porosity, bleeding oil, and water. The total depth of 5,885 feet is the greatest yet drilled in the area to date. A thick section of 1,375 feet of San Andres was drilled with the base not yet reached.

A discovery well producing from this zone was drilled in 1941, but not given a potential test until January 9, 1942. The well was Ray Albaugh's J. J. Handley No. 1, Sec. 36, Block M, E.L. R.R. Survey, Dawson County, slightly more than a mile east of the same operators' small discovery pumper—the Robinson No. 1 drilled in 1937. The Handley No. 1 pumped potentially 181 barrels of 33° gravity oil and 8 per cent water per day from a pay zone of 4,917–4,980 feet. The new pool has been designated the Welch pool. Top of the San Andres group

was found at a depth of 4,600 feet (−1,514). The oil occurs in finely granular and porous dolomite.

There was little activity in the vicinity of the Seminole field in Gaines County. The field was extended by an offset one mile southeast. In addition, one well, the Ohio Oil Company's Averitt No. 6, Sec. 228, Block G, W.T. R.R. Survey, was structurally low and defined the limit of production on the southwest part of the field.

C. *Wasson pay zone.*—The new Ownby pool resulted from a test drilled early in the year, the Livermore Drilling Company's Ownby No. 1, Sec. 502, Block D, J. H. Gibson Survey, Yoakum County. During the remainder of the year 5 producing wells were completed in the pool. The field produces from the lower part of the Wasson zone which is equivalent to the Waples-Platter "pay" 4 miles southwest. Structurally the field is on one of a series of anticlines extending southwestward through the Waples-Platter pool and forms the east limb of the Wasson field. The stratigraphic markers follow: top of anhydrite (Rustler), 2,560 (+1,998); top of Yates sand, 3,360 (−198); top of Yoakum dolomite (Queen), 4,330 (−772); top of San Andres group, 4,690 feet (−1,132). The first gas, amounting to 50,000 cubic feet per day, was encountered at 5,150 feet and increases accumulated to 1½ million cubic feet per day at 5,216 feet. The first oil occurred at 5,220 feet and broken increases were logged to the total depth of 5,348 feet, the over-all pay thickness being 198 feet. As an initial potential the well produced 130 barrels of 30° gravity oil in 6 hours; flowing through ⅝-inch choke on 2-inch tubing. Gas-oil ratio was 1,980 cubic feet of gas per barrel of oil. The pool was limited on the west by S. D. Dunn's R. L. Moore No. 1, a mile west of the discovery in Sec. 486. This test indicated a reversal in the regional dip toward the east by being 65 feet lower on the top of the San Andres than the discovery. It recovered only sulphur water by a bailing test and was abandoned at 5,502 feet.

Several unsuccessful wildcats were drilled between the Wasson and the Slaughter fields. The Texas Company's Murphy No. 1, Sec. 22, Block K, P. S. L. Survey, Terry County, recovered encouraging showings of oil in cores but was abandoned after more complete tests yielded chiefly water at the total depth of 5,440 feet. Likewise, the Honolulu Oil Corporation's Wright No. 1–13, Sec. 13, Block D, J. H. Gibson Survey, Yoakum County, was abandoned after logging only sulphur water at 5,410 feet. Nearer the Slaughter field in Terry County, the American Drilling Corporation's W. T. Hufnall No. 1 was finally abandoned in December after showing pin-point porosity in slightly bleeding cores from 5,198 to 5,248 feet. Sulphur odor indicated water from 5,256 feet to total depth of 5,435 feet. Finally, the

Sinclair Prairie Oil Company abandoned Kleiner No. 1 as a failure, after swabbing yielded only 15 barrels of oil and 7 barrels of water in 24 hours. The location of this test was Sec. 436, Block D, J. H. Gibson Survey, Yoakum County, 3½ miles northwest of the Ownby pool.

Development of the Wasson field in Yoakum and Gaines counties slackened appreciably as compared with 1940 activity. Of the 265 wells drilled, most were concentrated in the western part of the field and in extending the northern limits. The southeast edge of the field was defined at one point by the Continental Oil Company's Moore No. 2-47, Sec. 47, Block AX, P. S. L. Survey. The well was abandoned after no showings of oil had been found at 4,997 feet.

Three miles southwest of the field, the Amerada's Ruth Hudson No. 1, Sec. 60, Block AX, P. S. L. Survey, was showing only a small amount of oil and water at 5,016 feet, with the probability that it would be abandoned as non-commercial early in 1942. Deeper drilling (discussed later) by one well exposed a third new zone for development, and a second well was abandoned in the Clear Fork.

D. *Slaughter pay zone.*—The Slaughter field in Cochran, Hockley, and Terry counties was the most active area in the region. Six hundred forty-nine wells were completed in a proved area which now includes approximately 57,000 acres, nearly equivalent to the size of the Wasson field. Present indications are for an even greater areal extent. This year's activity extended the field short distances north and also southeast into Terry County for first commercial production in that county.

Two wells limited the structurally high northeast part of the field. The Magnolia Oil Company's Maple-Wilson No. 2, in Labor 10, League 41, Maverick County School Land Survey, Hockley County, found little barren porosity in the regular Slaughter zone and was drilled into the Glorieta sandstone, the basal member of the San Andres group. The well was abandoned at 5,596 feet. The other limiting well was the Delta Drilling Company's Watson No. 1, Labor 56, League 40, Maverick County School Land Survey.

A wildcat extension well, the Bieg Oil Company's (formerly J. O'Neal) D. S. Wright No. 1, located 3 miles north of the northwestern limits of the field in Labor 12, League 60, Martin County School Land Survey, Cochran County, was completed at the close of the year, potentially gauging 450 barrels of 30° gravity oil, pumped after a multi-stage acid treatment totaling 16,000 gallons.

A small discovery area, 2½ miles west of the Slaughter field in Cochran County, was disclosed by R. Rhodes and Atlantic Oil and Refining Company's Honolulu-C. S. Dean No. 1, Labor 4, League 89, Lipscomb County School Land Survey. The oil occurs in the Slaughter zone of the San Andres. A thin pay section and a close association of

oil and water make exploitation hazardous. A north offsetting well to the pumper-discovery was abandoned as non-commercial after testing mostly water.

The initial exploration within the field for oil below the regular Slaughter zone was conducted by the Atlantic Oil and Refining Company with its Boyd No. 21 in Cochran County. The well was drilled into the Yeso-Clear Fork group to the total depth of 7,000 feet but was found barren and was plugged back for completion in the regular zone. The San Andres was reached at 4,200 feet, the Glorieta sand at 5,590 feet. The upper limit of the Yeso-Clear Fork is not definitely known due to lag in the rotary cuttings, but it appears to be near the depth of 5,800 feet. That part of the Yeso-Clear Fork drilled was discouraging in that the section was broken and lacked porosity.

5. *Holt pay zone-lower San Andres.*—Few wells were drilled to the Holt pay zone of Andrews and Ector counties in 1941, yet the discovery of oil in a presumably equivalent part of the geologic section in the Abell field of northern Pecos opened the possibility of widespread development there. The Siemoneit Drilling Company's W. T. Walsh *et al.* No. 1, Sec. 25, Block 9, H. & G.N. Survey, was completed with a natural flow of 265 barrels of 35.8 gravity oil through perforated casing at a depth of 3,350–3,370 feet. The top of the Yates sand was found at 1,180 feet (+1,206) and the top of San Andres at 2,300 feet (+79). The second area of Holt production was found by the Stanolind's Thrapp-Walker No. 1, Sec. 25, Block 9, H. & G.N. Survey, 3 miles northwest of the Siemoneit well, which was completed, at the plugged-back depth of 3,289 feet, as a pumping test of 23 barrels of 26° gravity oil and 25 barrels of water in 24 hours.

Several different opinions have been advanced regarding the age of the Holt pay zone. Secor, Fritz, and West[36] have considered it as lower Guadalupe in age, but Cole, Dickey, and Kraus[37] have considered it as upper Clear Fork (?). Cole and Linehan[38] considered it middle San Andres. The authors of the Permian part of this paper believe that sufficient evidence has been obtained by 1941 drilling to and below this zone to indicate the Holt zone as lower San Andres in age. The Stanolind's W. F. Cowden No. 1-B attempted to extend the north Cowden Deep pool (Holt "pay") 1 mile west. The well, in Sec.

[36] Dana M. Secor, W. C. Fritz, and W. W. West, "Developments in West Texas and New Mexico during 1939," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 6 (June, 1940), pp. 1037–38.

[37] Taylor Cole, R. I. Dickey, and E. Kraus, "Developments in West Texas and New Mexico during 1940," *ibid.*, Vol. 25, No. 6 (June, 1941), pp. 1053–54.

[38] Taylor Cole and C. M. Linehan, "Insoluble Residue Study of Holt Pay, Ector County, Texas," *ibid.*, Vol. 24, No. 9 (September, 1940), p. 1700.

12, Block 44, T. 1 N., T. & P. R.R. Survey, was unsuccessful and was abandoned at 7,000 feet, after coring only scattered oil stain and porosity. However, this was the first well to penetrate the San Andres section in the area, and, with the Ellenburger test (Phillips' University No. 1), shows a complete section of San Andres. The stratigraphic markers are: top of Rustler anhydrite, 1,620 feet (+1,490); top of Yates sand, 2,800 feet (+310); top of Grayburg, 3,855 feet (−745); top of San Andres, 4,240 feet (−1,130); Holt pay zone, 5,190–5,260 feet; top of Clear Fork, 5,310 feet (−2,200).

Other wells that failed to produce in the Holt zone were the Phillips Petroleum Company's Embar No. 2, Sec. 5, Block 44, T. 2 N., T. & P. R.R. Survey, Andrews County, which was abandoned as dry after being drilled to 5,864 feet. The Clear Fork was drilled from 5,320 to 5,864 feet. No oil, gas, or water was reported in the Holt zone. Midway between the Goldsmith and Foster pools, the Landreth Production Corporation and Shell Oil Company's J. L. Johnson well, Sec. 43, Block A-43, T. 1 S., T. & P. R.R. Survey, Ector County, found the Holt zone dry, as were those of the Grayburg and San Andres. The top of the Holt zone was at 5,155 feet. The well was abandoned at 5,308 feet.

6. *Yeso-Clear Fork group.*—Numerous tests were drilled over a widely scattered area of West Texas which penetrated into the Yeso-Clear Fork group of rocks. Sixteen wildcat wells in the north part of the basin tested at least its upper part. Of these, the Lubbock County discovery, described previously, was of outstanding interest and the remainder added greatly to the hitherto meager data. Though more information is needed before definite correlations can be made, it is now apparent that facies changes similar to those in the overlying rocks must be expected.

The Sharon Ridge pool in western Scurry County, producing from the upper part of the Clear Fork, was further defined during 1941 by several dry holes on the northwest. Two relatively low wells in eastern Borden County were abandoned after finding water in the Clear Fork zone: B. C. Mann's Canning and Reynolds No. 1, Sec. 151, Block 25, H. & T.C. Survey, reached a depth of 2,600 feet; and Mel Richards' W. R. Drum No. 1, Sec. 307, Block 97, H. & T.C. Survey, was abandoned at 3,050 feet.

In Crosby County a remote well, Callahan and Wagner's E. M. Wahlenmaier No. 1, Sec. 3, Block D-15, penetrated 555 feet of the Clear Fork group but found no oil and only a little water. However, a showing of oil was found in the San Andres from 2,900 to 2,920 feet, and the hole was plugged back to 3,050 feet to test this zone. After a

shot with nitro-glycerine and an acid treatment, the well was abandoned as non-commercial. The San Andres group was entered at a depth of 2,117 feet (+538) and the Clear Fork at 3,463 feet.

Murchison's Sawyer No. 1, a dry hole in the regular Wasson zone and a limiting well on the north side of that field in Yoakum County, was drilled deeper during 1941 by the same operator to test the possibilities of the Wasson Deep level. The well, located in Sec. 702, Block D, John H. Gibson Survey, encountered Yeso-Clear Fork sand at 6,040 feet and drilled slightly porous barren dolomite to 6,850 feet, where mechanical difficulties forced abandonment. The San Andres section was 1,405 feet thick.

7. *Wichita* (?).—The Tubb "pay" was found in two areas in the Abell field, about $4\frac{1}{2}$ miles apart. The Stanolind's Lewis Rathjen No. 1, Sec. 26, Block 9, H. & G.N. Survey, made on initial test 758 barrels of 35.5° gravity oil in 24 hours at the depth of 3,950 feet. The top of the Yates sand was found at 1,230 feet (+1,138) and the San Andres at 2,365 feet (+3). The Stanolind's Conry-Davis No. 1, Sec. 31, Block 9, H. & G.N. Survey, was completed at a plugged-back depth of 3,815 feet, flowing 346 barrels of 35.2° gravity oil per day.

In the north Goldsmith pool of northwestern Ector County, M. A. Grisham *et al.* R. B. Cowden No. 1-A, Sec. 4, Block 45, T. 1 N., T. & P. R.R. Survey was completed at 6,431 feet as a small well in the upper part of the Wichita. The well underwent a long period of testing in which a daily swabbing rate of 16 barrels of oil and 18 barrels of water was established from a zone extending from 6,240 to 6,436 feet. A showing was also made in the Clear Fork at a depth of 5,801 feet where the 10 barrels of oil per day were recovered after a 2,000-gallon acid treatment.

DEVELOPMENTS IN PRE-PERMIAN OF WEST TEXAS

Development in 1941 in West Texas, in pre-Permian exploration, was the greatest in the history of this area. The area of greatest activity was in the counties of Crane, Crockett, Pecos, Reagan, and, to a lesser degree, Andrews. Toward the close of the year, exploratory work was under way in adjoining counties on the east, north, and west. There were 106 pre-Permian wells completed in West Texas during the year.

Considerable geophysical exploration has been conducted in Crockett, Irion, Reagan, Schleicher, Sterling, and Tom Green counties. Large blocks of acreage have been either leased on known geophysical data, or are being explored by geophysical instruments.

Ellenburger production of Crane County.—The development in the Gulf "A" Tubb area on the south end of the Sand Hills field has been

slow. Ten wells were drilled, seven of which are producing from the Ellenburger; two were plugged back to the Permian for producers, and one was dry and abandoned in the Ellenburger. At the close of the year, there were four non-productive Ellenburger wells, of which two are producing from the Permian and twelve were Ellenburger producers. Production is found between 5,680 and 5,780 feet. Initial potentials have been as high as 10,327 barrels of oil per day.

New discoveries in pre-Permian in Crane County.—The Gulf Oil Corporation's Tubb No. 1-B, a discovery in September, 1941, is located in south-central Crane County, 660 feet from the south and west lines of Sec. 28, Block B-27, P. S. L. Survey, 2 miles south of the Gulf "A" Tubb area. The well made 6,905 barrels of 36.4° gravity oil in 24 hours, with a gas-oil ratio of 6,103:1. It was completed at 5,660 feet in the Ellenburger, the top of which was reached at 5,604 feet (sub-sea datum, 3,142 feet). Production is predominantly from fractured dolomite. Immediately below the "pay," a sulphur-water zone is difficult to plug off if drilled into. At the close of the year, three wells had been completed, one temporarily abandoned (possibly dry), two producing in the Ellenburger, and one drilling.

A mile and a half south is the Gulf Waddell No. 17 area, which may connect with Gulf No. 1-B area. The Gulf Oil Corporation's Waddell *et al.* No. 17, in the east corner of the E. ¼ of Sec. 15, Block 3, H. & T.C. R.R. Survey, was completed, March 27, 1941, flowing at the rate of 1,242 barrels of 37.7° gravity oil through 2-inch tubing with a gas-oil ratio of 2,185:1. It was stopped at 5,648 feet in Ellenburger dolomite, the top of which was at 5,584 feet (sub-sea datum, 3,121 feet), and the top of the "pay" was at 5,630 feet.

At the close of the year, four producers had been completed, and the fifth well was completed, January 1, 1942, with initial production of 9,770 barrels of oil per day.

The stratigraphic section drilled in the Tubb No. 1-B and Waddell areas is as follows.

	Depth in Feet
Surface and Dockum group (Triassic)	0– 290
Permian	
Ochoa series	290–1,240
Guadalupe series	1,240–2,470
Leonard and Wolfcamp series (undifferentiated)	2,470–5,584
Ellenburger (Lower Ordovician)	5,584–5,648

Simpson production (Middle Ordovician), Crane County.—The Continental Oil Company's Jones No. 1, a discovery, 1½ miles south of the Gulf's Waddell No. 17 area, is in the north corner of the N. ¼ of Sec. 12, Block 3, H. & T.C. R.R. Survey, in southwest-central Crane County. It is probably on the flank of a narrow Ellenburger structural

"high," trending northward from the Abell pool in Pecos County, to the Sand Hills pool in west-central Crane County. This well encountered lower Simpson at 5,545 feet (−3,071), and was drilled into the Ellenburger 106 feet to the total depth of 6,146 feet. On a drill-stem test, the Ellenburger showed 4,860 feet of sulphur water. The well was plugged back to 6,015 feet. The Waddell sand and a lower sand member from 5,905 to 5,927 feet flowed 83 barrels of 42.3° gravity oil. This lower sand member has showings of distillate and gas in the Sand Hills pool.

The stratigraphic section drilled in this well follows.

	Depth in Feet
Surface and Dockum group (Traissic)	0– 240
Permian	
Ochoa series	240–1,270
Guadalupe series	1,270–2,540
Leonard and Wolfcamp series (undifferentiated)	2,540–5,545
Simpson (Middle Ordovician)	5,545–6,040
Ellenburger (Lower Ordovician)	6,040–6,146

Simpson production (Middle Ordovician), Abell field, Pecos County, Texas.—The Abell field has had a very rapid development, due to short-term leases; fifty-five wells were completed in 1941. Of this total, only one, the Sinclair Prairie's Grove No. 1, was dry and abandoned. in the Ellenburger. It showed nothing but water in the McKee and Waddell sands and the Ellenburger was dry. One gas well has been temporarily abandoned. Forty wells were completed as producers in the McKee sand. In addition, seven are producing from the Waddell sand, of which three are gas wells, one is producing from the Ellenburger, and five were plugged back as producers into the Permian. The structure is complicated by two or more small faults. The west and south sides of the field have been very prolific, with the wells gauging 1,400 to 2,200 barrels of 43° gravity oil. The pay sand in this area averages 15–25 feet in thickness. In the north-central part of the field the sand is shaly and in many wells gas, oil, and water are closely associated. In this area there is considerable gas, varying from 40 million to 60 million cubic feet per day. This gas area occupies the highest position on the structure. There is more than 500 feet of structural relief from the highest to the lowest producer on the McKee sand datum. In some wells the McKee sand is missing, in others the Waddell. The top of the Simpson is an eroded surface, as much as 600 feet being missing locally. For example, the Magnolia's Grove No. 1 went out of the Permian directly into the McKee sand.

The Stanolind Oil and Gas Company's Conry-Davis No. 1, Sec. 31, Block 9, H. & G.N. Survey, about 4 miles southeast of the Abell pool, Pecos County, was drilled to 5,795 feet. It encountered Ellen-

burger below the base of the Permian at 4,825 feet (−2,449) and pre-Cambrian granite at 5,740 feet (−3,364). The Ellenburger tested sulphur water and the well was plugged back to 3,815 feet, where it produced in the Permian.

Pecos County (Cambro-Ordovician).—One of the important wildcats, the Gulf Oil Corporation's Millar *et al.* No. 1, southwest corner of Sec. 39, Block 11, H. & G.N. R.R. Survey, about 18 miles southeast of the Apco pool, was dry and abandoned at 4,538 feet in pre-Cambrian granite, which was encountered at 4,532 feet (−1,955). There was a reworked detrital section from 4,498 to 4,532 feet, above which the Permian limestone and dolomite showed some scattered porosity and slight staining. This is the shallowest pre-Cambrian "high" found in West Texas to date.

A second well, the Gulf Oil Corporation's Millar *et al.* No. 2, which opened the Millar pool, Sec. 43, Block 11, 1½ miles north and west of Millar No. 1, went out of the Permian into Ellenburger at 4,146 feet (sub-sea datum, 1,612 feet), or 343 feet higher structurally on the base of the Permian than the No. 1. A total of 237 feet of lower Ellenburger was drilled. It was completed in December at the total depth of 4,383 feet, producing 263 barrels of 33.7° gravity oil, with a gas-oil ratio of 2,757:1. Production would not hold up, and it has been periodically deepened since its original completion. The stratigraphic section follows.

	Depth in Feet
Cretaceous (Triassic)?	0– 470
Permian	
Ochoa series	470– 700
Guadalupe series	700–1,580
Leonard and Wolfcamp series (undifferentiated)	1,580–4,146
Ellenburger (Lower Ordovician) and Upper Cambrian	4,146–4,383

Culbertson and Irwin's Mary Heiner No. 1, the discovery well of the Heiner pool, 660 feet from the north and east lines of Sec. 589, G.C. & S.F. R.R. Survey, northwest Pecos County, was completed, March, 1941. The top of the Ellenburger was at 5,128 feet (sub-sea datum, 2,579 feet), and was overlain by 18 feet of detrital material. The upper part of the Ellenburger was highly fractured. At the total depth of 5,663 feet, the operators encountered sulphur water, then plugged back to 5,509 feet. Between 5,382 and 5,485 feet, there were thin streaks of stained and saturated dolomite. This well on gas lift, gauged 36 barrels of oil per day plus 2 per cent basic sediment and water, with a gas-oil ratio of 3,771:1. One noteworthy thing about the well was the exceptional amount of porosity, oil stain, dried oil, and asphalt (gilsonite) found throughout the Permian limestone section. The stratigraphic section penetrated follows.

	Depth in Feet
Surface	0– ?
Permian	
Ochoa series	?– 800
Guadalupe series	800–1,815
Leonard and Wolfcamp series (undifferentiated)	1,815–5,128
Ellenburger (Lower Ordovician)	5,128–5,663

The Apco pool[39] in north-central Pecos County, has had a rather slow development, probably due to lack of adequate pipe-line connection. Eight wells were completed in 1941, two of which on the west side were dry and abandoned in pre-Cambrian rocks. One well, Olson and McCandless' Crockett No. 1, the discovery well of the southwest extension area in 1940, was deepened to granite, or igneous rock, and according to the operators they encountered additional "pay" in Cambrian igneous wash, thereby reducing its high gas-oil ratio. This igneous wash gives an additional pay zone for this area. At the beginning of the year, three wells were being drilled in the field proper, and one wildcat 2 miles west.

The Apco pool is on a truncated pre-Permian structural feature with much of the Ellenburger removed. Production is from lower Ellenburger which generally has a cavernous type of porosity but in places is fractured dolomite. There are easily recognizable cherts in this pay zone. On the northeast side of the pool, wells have been drilled into gabbro (schistose in structure), which may be equivalent to the Pack Saddle schist of the Llano uplift. Wells on the southwest have encountered igneous material near the base of the Ellenburger.

Reagan County, Ellenburger production.—The Barnhart pool of southeastern Reagan County, may be considered one of the most important field discoveries of West Texas in 1941. The Amerada's University 1-RA, SE. $\frac{1}{4}$, NE. $\frac{1}{4}$ of Sec. 3, Block 48, Univerisity Lands Survey, was drilled to 9,294 feet, and was plugged back to 9,082 feet where it gauged 187 barrels of 44.2° gravity oil in 4 hours, with a gas-oil ratio of 2,140:1. At the close of the year, there were two producers and one drilling well.

The Big Lake field had one extension this year $\frac{1}{4}$ mile northeast, the Big Lake Oil Company's University No. 18-C, in Reagan County, Sec. 25, Block 9, University Survey. The lower Strawn "crinoidal" limestone was encountered at 8,165 feet (−5,495), overlying Ellenburger, which was reached at 8,205 feet. No Simpson was present, as in other wells on top of the structure. The "pay" was at 8,275 feet and the well was completed at 8,301 feet, flowing 77 barrels of 47° gravity oil per hour with 7,775,000 cubic feet of gas.

[39] Taylor Cole, "Ordovician Development, Apco Structure, Pecos County, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 3 (March, 1940), pp. 478–81.

Strawn production (lower Pennsylvanian).—The Todd field,[40] Crockett County, discovered in March, 1940, is producing from a crinoidal limestone of lower Pennsylvanian age, equivalent to the Millsap Lake group (lower Strawn). There were seven wells completed this year in this area, six of which were producers in the "crinoidal" limestone. One, the Amerada's Todd No. 1-D, Sec. 12, Block 10, G.C. & S.F. R.R. Survey, was dry and abandoned at 6,367 feet. This well marks the northern extremity of the field.

Wells off structure have encountered from a few feet to 204 feet of Simpson sediments. There were four wells that had Simpson, three of which drilled into the Ellenburger, but were plugged back to the "crinoidal" limestone. At the close of the year, there was one drilling well. The Todd field is on a narrow northwest-southeast structure as mapped on the "crinoidal" limestone, with a very steep dip of more than 500 feet in less than ½ mile. The field is outlined more or less by dry holes on all sides except the northeast. The producing limestone is a reef deposit thinning toward the east and north and thicker on the higher part of the structure.

A probable new area, producing from the limestone of lower Strawn age, was found by the Amerada's Todd No. 1-C, Sec. 15, Block 10, G.C. & S.F. R.R. Survey, 3½ miles west of the Todd field, which produced 86 barrels of oil and 219 barrels of water at a plugged-back depth of 6,548 feet, and was drilled to the total depth of 7,143 feet. The lower "crinoidal" limestone was topped at 6,436 feet (−4,006), the Simpson at 6,645 feet (−4,215), and the Ellenburger at 6,975 feet (−4,545). A second well, 1½ miles southeast, was drilling at the end of the year.

Silurian production, Shipley deep pool, Ward County, Texas.—Only one well was drilled in the Shipley deep pool during 1941, the Gulf Oil Corporation's Wristen No. 6, an east offset to the discovery well. It flowed 782 barrels of 33.4° gravity oil through casing and tubing. The total depth is 7,080 feet, and the top of the "pay" is 7,002 feet.

PRE-PERMIAN WILDCATS

Redmond and Greene *et al.* Iowa Realty Trust No. 1, was located in the center of the E. ¼, W. ¼ of Sec. 29, Block 19, H. & G.N. R.R. Survey, north-central Pecos County, 2½ miles north of Culbertson and Irwin's small Ellenburger producer. It encountered Simpson below the Permian, whereas the Culbertson and Irwin well had Ellenburger. It was dry and abandoned at 6,010 feet in Simpson, which was

[40] D. D. Christner, "Todd Ranch Discovery, Crockett County, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 6 (June, 1940), pp. 1126–27.

found at 5,370 feet (sub-sea datum, 2,844 feet), with 25 feet of overlying detrital material. The operators tested upper Permian showings to no avail. This well had several minor oil and gas showings in the Permian, whereas the Culbertson and Irwin well showed an exceptional amount of porosity and asphalt, which was absent in this well.

The Gulf Oil Corporation's University No. 1-F, Sec. 22, Block 31, University Survey, Crane County, was dry and abandoned at 10,659 feet. It is approximately 11 miles northwest of the Gulf Oil Corporation's McElroy No. 103 dry hole, which was drilled in 1935 to the total depth of 12,786 feet. The section penetrated in the No. 1-F is considerably thinner than that in the Gulf's McElroy 103.[41]

	Depth in Feet
Surface	85
Triassic	680
Permian	
Ochoa series	1,852
Guadalupe series	3,217
Leonard series	7,060
Wolfcamp	7,060
Base of Permian (top detrital, 7,190)	7,240
Top of Pennsylvanian	7,240
Top of Devonian	8,187
Top of Silurian	9,290
Top of Montoya	9,470
Top of Simpson	9,630
Top of Ellenburger	10,628 (−8,054)

The Phillips Petroleum Company's University-Andrews No. 1, Sec. 32, Block 10, southwestern Andrews County, near the south county line, was temporarily abandoned at 8,368 feet in Ellenburger. The Simpson was encountered at 7,940 feet (−4,702), and was overlain by 100 feet of detrital material. Some staining in sand members was observed. The Ellenburger was reached at 8,353 feet (−5,115), and tested sulphur water.

The Magnolia Petroleum Company's Walton No. 20, Sec. 4, Block B-3, P.S.L. Survey, in north-central Winkler County, near the New Mexico State line, was dry and abandoned at 8,448 feet. The base of the Permian was found at 7,620 feet (−4,686), below which the well went into probably lower Mississippian and stopped in Devonian rocks.

Amon G. Carter's Wasson No. 4-D, Sec. 50, Block AX, P.S.L. Survey, Wasson pool, northwestern Gaines County, near the Yoakum County line, was drilled to 11,108 feet. It is reported to have stopped in Ellenburger, but no information has been released. It was plugged back to 7,433 feet as a producer in the Permian.

The Humble Oil and Refining Company's Elwood Estate No. 1,

[41] Sample tops by Taylor Cole.

south-central Mitchell County, Sec. 49, Block 16, S.P. & R.R. Survey, was dry and abandoned at 8,002 feet in Ellenburger. The San Andres was encountered at 1,240 feet, the Pennsylvanian at 5,780 feet, a basal Pennsylvanian detrital zone at 7,728 feet, and the Ellenburger at 7,818 feet (−5,583).

The Humble and Oil Refining Company *et al.* Byrd No. 1, Sec. 17, Block K, T.T. & R.R. Survey, southeastern Hale County, was dry and abandoned at 6,760 feet (−3,509), in pre-Cambrian granite. This well encountered granite at approximately the same sub-sea datum as the Humble Oil and Refining Company's Westheimer No. 1 dry hole, situated about 85 miles distant in the northwestern part of Cochran County, near the Texas-New Mexico State line. Lower stratigraphic markers in the Humble's Byrd well follow.

	Depth in Feet
Top of Mississippian	6,605
Base of Osage	6,715
Top of Cambrian	6,715
Top of pre-Cambrian	6,745

The Humble Oil and Refining Company's Matador Land and Cattle Company No. 1-C, Sec. 29, Block JR, G.B. & C.N.G. Survey, near the northeast corner of Motley County, was dry and abandoned at 7,430 feet in lower Pennsylvanian rocks.

The Humble Oil and Refining Company's Matador No. 1-D, Sec. 127, J. H. Gibson Survey, in the southeastern part of Motley County, about 16 miles south of the Humble's Matador No. 1-C dry hole, reached the pre-Cambrian granite at 6,266 feet (−3,901), and was abandoned as a dry hole at 6,269 feet. Pennsylvanian rocks overlie the granite.

DEVELOPMENTS IN SOUTHEASTERN NEW MEXICO DURING 1941

There were 371 wells drilled in southeastern New Mexico during 1941, of which 294 were oil wells, 7 gas wells, and 70 dry holes. The percentage of dry holes (19 per cent) was the highest attained in the area in the past several years. This may be attributed both to the slightly higher percentage of failures for exploratory wells and to the more direct influence of the large percentage (28 per cent) of dry holes completed in the Red Lake area and the contiguous part of the Artesia pool in Eddy County. Principal development in that area involved drilling wells only 400 to 500 feet deep, so that, though dry holes were large in number, they totaled little footage.

A total of slightly less than 40 million barrels were produced in the district during the year.

DISCOVERIES

Four new discoveries were recorded during the year.

In Eddy County, W. A. Sudderth's Wills No. 1, Sec. 14, T. 20 S., R. 28 E., was completed as a 3 million-cubic-foot sour gas well at the total plugged-back depth of 930 feet. The well was completed at the end of August, and has been shut in since, no market being available for the gas. The top of the Yates sand was encountered at 695 feet, and the well was drilled to the total depth of 965 feet before being plugged back. The gas is either in the lowermost part of the Yates formation, or in the upper part of the Seven Rivers. No additional drilling has been done in the vicinity of the discovery.

In November, two wells 2½ miles apart encountered oil in the same week and must, therefore, be considered joint discovery wells of a new pool. The two wells were Sanders Brothers' Leonard No. 1, Sec. 34, T. 16 S., R. 30 E., and Ney Hightower's Grier No. 1, Sec. 31, T. 16 S., R. 31 E. Both wells produced from the base of the Grayburg, which in the first well was encountered at 2,640 feet, and in the second well at 2,800 feet. Other markers in the Sanders' Leonard were the Yates encountered at 1,345 feet, the Queen at 2,215 feet, and possibly the San Andres at 2,972 feet. It was completed at the total depth of 2,982 feet in sand, and produced 77 barrels of oil per day after a shot. Hightower's Grier was completed at 3,118 feet in sand and produced 390 barrels of oil per day, natural. It reached the Yates at 1,515 feet, the Queen at 2,385 feet, and no San Andres could be identified to the total depth. Both of these wells are in areas previously named, and the new pool will probably not be specifically designated, but production from it included in the present High Lonesome, Robinson, and Grayburg-Jackson areas. Information on structure so far available indicates only unimportant terracing, and the accumulation is probably of the stratigraphic trap type against the Artesia-Maljamar nose. It is expected that the pool will have the same relationship north of the Grayburg-Jackson area that the Loco Hills pool has on the south. Development since discovery indicates that the area between the wells will be productive, and that the limits of the pool, as at Loco Hills, will be determined by cementation of the sand and possible lenticularity.

Late in the year, Paul English completed Jones No. 1, Sec. 24, T. 19 S., R. 31 E., at the total depth of 2,475 feet. It is capable of pumping 130 barrels per day of 32.1° gravity oil from a sand near the top of the Yates formation which was reached at 2,377 feet. The discovery is on a sharp east-west nose. The successful completion by Culbertson and Irwin of the Lynch No. 1, 2½ miles east, indicates the discovery of another pool on the same regional feature. At present the English well

is within the previously named Shugart area of Eddy County, and the Culbertson and Irwin well is in the previously named South Maljamar area of Lea County.

In Lea County, the only discovery for the year was Leonard and Welch's State No. 1, Sec. 18, T. 20 S., R. 33 E., completed in June. The well was drilled to 3,103 feet after encountering the top of the Yates at 2,795 feet and in an 8-hour pumping test produced 65 barrels of 26.4° gravity oil. Production is near the Yates-Seven Rivers contact. Four producers were completed during the year in the pool which has been named Salt Lake. The discovery is variously credited to subsurface, torsion-balance, and soil-analysis methods.

In the McMillan area, bordering Lake McMillan in Eddy County, Fulton *et al.* Johnson No. 1 was completed, capable of pumping 8 barrels of oil and 25 barrels of water after a 230-quart shot, and 1,000-gallon acid treatment. Since it was completed in April and plugged in November, it can not be considered a commercial well and is not, therefore, listed as a discovery. It is located in Sec. 22, T. 19 S., R. 27 E., 3 miles northeast of the McMillan pool.

DEVELOPMENTS IN PREVIOUSLY DISCOVERED POOLS

The most active development during the year was in the Maljamar area where 61 wells were completed, three of which were dry holes. Both the "sand" area on the south flank and the "lime" area on the crest of the nose were included in the development, but more wells were drilled in the flanking sand part of the pool. Of especial interest is the well drilled by Barney Cockburn on the Westall-State in the northwest corner of Sec. 36, T. 17 S., R. 32 E., on the southeast edge of the field. This well was dry in the regular "pay," and was deepened to the total depth of 4,725 feet, where, after a shot, it pumped at the rate of 47 barrels of 39.8° gravity oil per day. The production is from sand, approximately 400 feet lower stratigraphically than the regular Maljamar "pay." It may be within the San Andres or a greatly thickened Grayburg. This well was structurally low, and the deeper pay zone encountered gives promise of deeper producing possibilities for the entire pool.

In the Red Lake and Artesia area, already mentioned, the principal development was shallow drilling to the Yates sand, varying in depth from 400 to 500 feet. The principal production from Red Lake in the past has been from a deeper Grayburg zone, between 1,900 and 2,000 feet. A few wells were again drilled to this zone.

The Loco Hills and Vacuum fields, which were most active during 1940, had 19 and 13 completions, respectively, in 1941, all of them oil wells. Both of these fields are essentially defined, but the south part of

the Vacuum pool, where exceptionally prolific wells have been obtained, may be slightly extended.

Nine wells were drilled in the West Eunice pool, three of which were dry holes. Development through the year indicated an important southwest extension, both through subsurface structural evidence and more prolific production. The Yates is the producing sand in this pool.

The Barber and PCA pools northeast of Carlsbad, Eddy County, continue to have a slow development with six new producers completed during the year. This production is also from the Yates.

Late in the year the Arrowhead pool was extended ½ mile north by the Repollo's Brownlee No. 2, in the southwest corner of Sec. 25, T. 21 S., R. 36 E. Eight producers were completed in this field during the year, and the extension will no doubt stimulate further drilling at the north end.

Other development in the southeast part of the state was fairly well distributed among the older producing areas. Seven gas wells were completed during the year, of which only four had ready market.

EXPLORATORY TESTS

Important exploratory wells include L. E. Elliott's State No. 1, Sec. 16, T. 11 S., R. 31 E., Chaves County. This well reached the total depth of 3,932 feet, having encountered the top of the San Andres at 3,210 feet. Water was encountered at the total depth, indicating satisfactory porosity. This is the only well drilled during the year in the Cap Rock area, which was brought into prominence last year with the completion of the Great Western's State No. 1-D, Sec. 30, T. 12 S., R. 32 E. This well produced for several months, but was abandoned in 1941.

Important exploratory tests, all dry and abandoned in Lea and Eddy counties, are listed in chronological order based on the date of completion, as follows.

Helmerich and Payne's State No. 1 was completed in June at the total depth of 5,635 feet. The top of the San Andres was encountered at 4,705 feet, and no important showings of oil, gas, or water were reported. The well, drilled in Sec. 3, T. 14 S., R. 38 E., is about 6 miles southeast of the Ventura's Lowe No. 1, an interesting test drilled in 1940 to the total depth of 6,300 feet. Helmerich and Payne's well confirmed the favorable structural position of the Ventura test, but the fact that both wells showed no porosity in the upper part of the San Andres gives little hope of developing production in that zone in this immediate area.

The Fullerton Oil Company drilled State No. 1, Sec. 18, T. 16 S.,

R. 33 E., to the total depth of 5,060 feet. The top of the Queen sand was encountered at 3,583 feet, and the San Andres at 4,385 feet. The well had a showing of oil before encountering water at the total depth. It was completed in August.

During the same month, Carl B. King completed State No. 1 in Sec. 16, T. 11 S., R. 38 E., in the Ranger Lake area at the total depth of 5,312 feet. The top of the San Andres was encountered at 4,370 feet, and no showings of oil, gas, or water were reported.

In September, H. G. Marshall *et al.* completed Cunningham-State No. 1, Sec. 22, T. 19 S., R. 35 E., in the Pearl area at 5,001 feet. No showings of fluids were reported. The top of the Yates was reached at 3,350 feet, and the San Andres had not been encountered at the total depth.

Seven miles west of the town of Lovington, J. W. Brown completed State No. 1, Sec. 4, T. 16 S., R. 35 E., early in October. The Yates was reached at 2,950 feet, the Queen at 3,810 feet, and the San Andres at 4,540 feet. The well was drilled to the total depth of 5,507 feet, then plugged back to 5,318 feet, where oil showings were previously encountered, and treated with acid and tested before abandonment.

Late in October, the Richmond Drilling Company completed Shell-State No. 1, Sec. 22, T. 17 S., R. 33 E., approximately midway between the Maljamar and the Vacuum pools at the total depth of 4,805 feet. The San Andres was encountered at 4,515 feet, and the well was both shot and acid-treated in an effort to develop commercial production. Porosity, however, was too poorly developed and the well was abandoned. Though structurally not exceptionally high, the evidence indicates that the well is on the extension of the Maljamar nose, which under favorable conditions is expected to be productive.

GENERAL

Repressuring is being attempted in the state. Two projects are actually in operation, one in Loco Hills and one in a part of the Langlie pool. These projects have not been in operation long enough to warrant conclusions concerning results obtained. The repressuring of the Maljamar field awaits completion of the plant, delayed by a shortage of material. An attempt by Culbertson and Irwin to repressure a small area in the Langlie pool was a failure when it was found impossible to inject sufficient gas at a reasonable pressure.

Again it must be noted that no exploration of zones deeper than those already drilled took place during the year.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE 1942), PP. 1040-1049, 1 FIG.

NEW DEVELOPMENTS IN NORTH AND WEST-CENTRAL TEXAS, 1941[1]

NORTH TEXAS GEOLOGICAL SOCIETY[2]
Wichita Falls, Texas

ABSTRACT

During the year 1941, the north and west-central Texas districts developed important new production in the following stratigraphic formations.

	New Discoveries	*Deeper Drilling*
Ellenburger dolomite (Cambro-Ordovician)	3	3
Mississippian limestone	5	2
Bend (Pennsylvanian)	2	
Caddo (Pennsylvanian)	9	
Strawn (Pennsylvanian)	9	3
Canyon (Pennsylvanian)	1	1
Cisco (Pennsylvanian)	3	2
Wolfcamp (Permian)	1	

The only new producing formation discovered in the area was the Dothan limestone (Permian) in the Merkel pool in Taylor County. To date, only one well is producing from this formation.

INTRODUCTION

The north and west-central Texas districts include the area from the Llano uplift in central Texas, northward to the Red River and from the eastern rim of the Midland basin on the west side to include the Fort Worth syncline on the east side.

The major structural features of the area are the Bend arch extending due northward from the Llano uplift into Wichita County flanked on the east by the Fort Worth syncline, which, commencing at approximately the center of the west line of Clay County, extends in depth southeastward through Clay County, across southern Montague County, through northeastern Wise County, and across central Denton County. The Electra arch extends from northern Clay County westward across north Wichita County and central Wilbarger and Foard counties. The Muenster arch extends through the southeast corner of Cooke County diagonally across that county toward the northwest and through northeastern Montague County. The Red River syncline parallels the Electra arch on the north and increases in

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, April 19, 1942.

[2] This paper was prepared by Lewis S. Coryell, Robert Roth, and Dolphe E. Simic from papers provided for the North Texas Geological Society by W. C. Bean and Clinton Engstrand, Shell Oil Company, Inc.; M. G. Cheney, Coleman, Texas; T. F. Petty and Robert Roth, Humble Oil and Refining Company; A. C. Hornady and B. L. James, Phillips Petroleum Company; F. E. Melott, Deep Rock Oil Corporation; D. D. Heninger, Ohio Oil Company; J. F. Gibbs, Panhandle Refining Company; P. M. Martin, Continental Oil Company; Henry Craig, Olney, Texas; Roy Seitz; P. E. M. Purcell, British-American Oil Producing Company; Carl Wheeler, Pure Oil Company; and Harry Emmerich, Magnolia Petroleum Company.

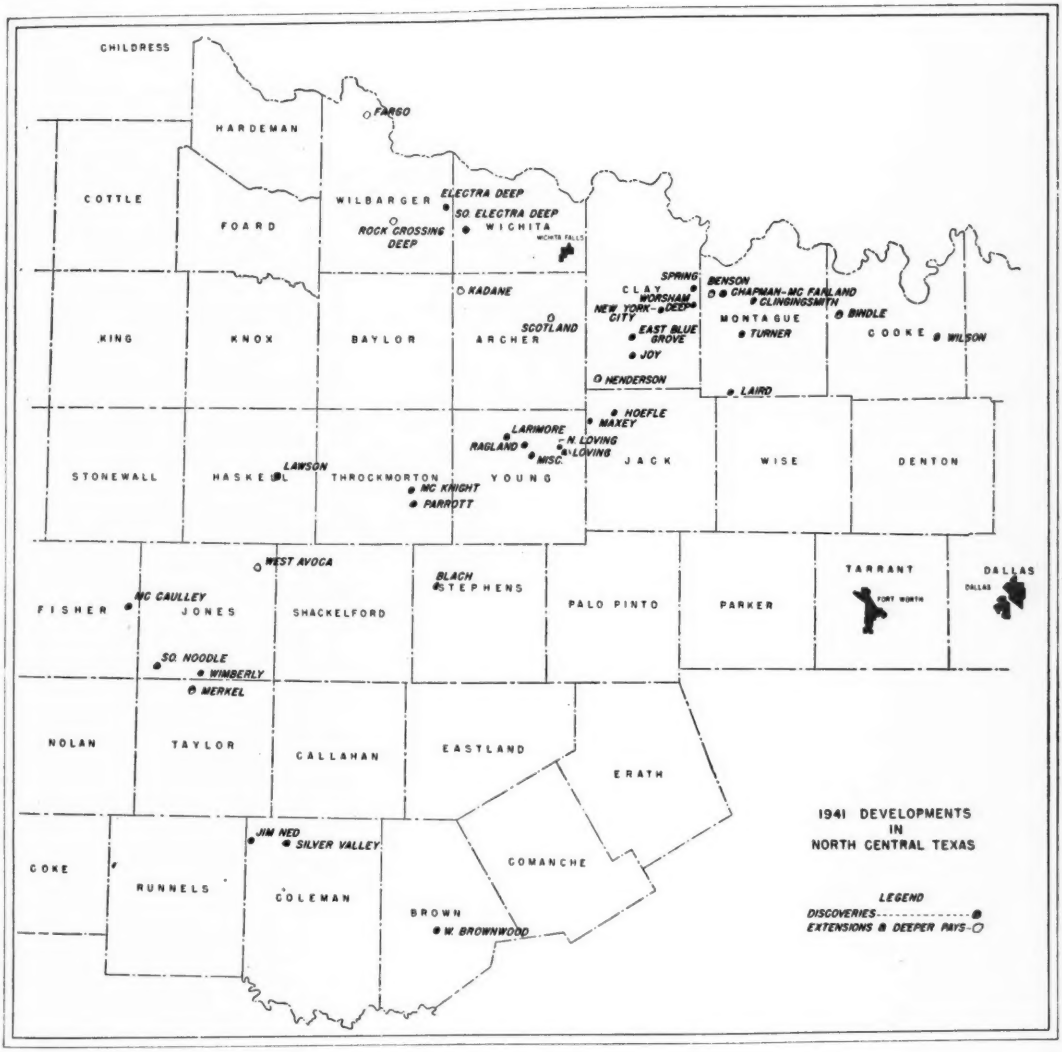

CHILDRESS
HARDEMAN
FARGO
COTTLE
FOARD
WILBARGER
ELECTRA DEEP
SO. ELECTRA DEEP
WICHITA
WICHITA FALLS
ROCK CROSSING DEEP
KADANE
SPRING
BENSON
CLAY
CHAPMAN-MC FARLAND
CLINGINGSMITH
WORSHAM
NEW YORK-CITY DEEP
MONTAGUE
BINDLE
KING
KNOX
BAYLOR
ARCHER
SCOTLAND
EAST BLUE GROVE
TURNER
COOKE
WILSON
JOY
HENDERSON
LAIRD
HOEFLE
MAXEY
LARIMORE
RAGLAND
N. LOVING
MISC.
LOVING
JACK
WISE
DENTON
STONEWALL
HASKELL
LAWSON
THROCKMORTON
MC KNIGHT
PARROTT
YOUNG
WEST AVOCA
BLACH STEPHENS
TARRANT
FORT WORTH
DALLAS
DALLAS
FISHER
MC CAULLEY
JONES
SHACKELFORD
PALO PINTO
PARKER
SO. NOODLE
WIMBERLY
MERKEL
NOLAN
TAYLOR
CALLAHAN
EASTLAND
ERATH
JIM NED
SILVER VALLEY
COKE
RUNNELS
COLEMAN
COMANCHE
BROWN
W. BROWNWOOD
1941 DEVELOPMENTS
IN
NORTH CENTRAL TEXAS
LEGEND
DISCOVERIES
EXTENSIONS & DEEPER PAYS

FIG. 1

depth westward as it enters Wilbarger County and continues to deepen westward through northern Hardeman County.

The wildcat activity in the north Texas district during the year 1941 consisted largely of the drilling of seismograph prospects.

The outstanding new development in the district for the year was the discovery of new productive pools in the Chappel limestone of Mississippian age. Several hundred feet of porous oil-bearing Chappel limestone was encountered in some localities.

ARCHER COUNTY

Among the more interesting wildcats drilled in Archer County during 1941 were the King Oil Company's Taylor No. 1, Sec. 13, A.T.N.C.L. Survey, and the Phillips Petroleum Company's Pendery No. 1, Sec. 13, Block 4, H. & T.C. R.R. Company Survey.

The Taylor No. 1, at the total depth of 5,050 feet in dolomite, was completed in limestone, identified as Chappel by most geologists, which overlies the dolomite. The initial production was 15.7 barrels in 24 hours pumping after acidizing. This is the first well to produce from this formation in northern Archer County.

The Phillips Petroleum Company's Pendery No. 1 was abandoned at the total depth of 6,355 feet in Ellenburger dolomite after having penetrated more than 1,000 feet of this formation, the greatest penetration of the Ellenburger in Archer County.

CLAY COUNTY

The New York City field is the most important deep production discovered in Clay County in 1941. This field was opened in April by the completion of the Shell Oil Company's E. D. Coleman No. A-1, Sec. 24, Calhoun County School Land, with an initial natural flow of 138 barrels of oil in 3 hours through $\frac{3}{4}$-inch choke from casing perforations in Chappel limestone from 6,158 to 6,268 feet. The gravity of the oil is 47° A.P.I. At the close of the year, six additional oil wells had been completed in the field, all producing from the Chappel limestone. This field is situated on a block of leases acquired by the Shell, following seismograph exploration. At the time of this discovery, the nearest profitable oil production from Chappel limestone was about 55 miles distant in southern Young County. Hence this discovery opened a broad area for exploratory drilling and, before the close of 1941, several new fields producing from Chappel limestone had been discovered in Clay, Archer, Jack, and Young counties.

Other discoveries of oil production from the Chappel limestone in Clay County include one well (Shell's H. Henderson No. 9-C) in the Antelope field, and the Joy field which was discovered by L. T. Burns

through the deepening of Wynn No. 1, Sec. 34, H. Williams Survey. This test had been abandoned in 1939 at a depth of 5,202 feet but was deepened in 1941 to 5,965 feet, 76 feet within the Chappel limestone. At this depth the well yielded approximately 50 barrels of oil per day.

Late in 1941, the Continental Oil Company completed an important discovery in its Spring No. 1, Sec. 24, Block 4, H. & T.C. R.R. Survey, which had an initial natural flow of 150 barrels in 8 hours from Caddo limestone, penetrated from 5,582 to 5,630 feet, total depth. This discovery is located on a 3,000-acre block which the Continental acquired on the basis of surface and subsurface mapping. Later the prospect was surveyed with seismograph and the location of this discovery was based on the interpretation of structure by seismograph.

During 1941, the Thornberry area in northwestern Clay County has been the locale of active exploration for shallow oil production which has resulted in the discovery of seven new shallow fields producing from upper Pennsylvanian strata. At the end of the year the largest of these fields covers only about 160 acres. Most of the new production was found in the 1,100-foot Thornberry sand which is possibly correlative with the Thomas sand of Archer County. The following notes regarding three of these new fields may be regarded as fairly representative of the area. The Hansard field was discovered in March by the completion of George Graham *et al.* Hansard No. 1, Block 8, Thornberry Subdivision, with an initial production of 100 barrels of oil per day by pumping. The producing Thornberry sand was found at 1,139–1,144 feet, total depth. At the close of the year, about 35 oil wells had been completed in this field. A second new field was discovered by Perkins and Cullum's C. T. Taylor No. A-2, Block 44, Bacon Subdivision, which was completed in March with an initial production of 50 barrels of oil in 13 hours from the Thornberry sand at 1,060–1,073 feet. About 25 oil wells had been completed in this field at the close of the year. A third field was opened in July by Golden *et al.* First Texas Joint Stock Land Bank No. C-1, Block 13, Thornberry Subdivision, which was completed with an initial production of 25 barrels of oil per day from the Thornberry sand at 1,123–1,137 feet. At the close of the year, about 18 oil wells had been completed in this field.

COLEMAN COUNTY

In May, 1941, the States Oil Corporation with Wooten, Reese, and Jay of Abilene opened a new area about midway between Novice and Silver Valley with their Hudson No. 1 as a 10 million cubic-foot gasser at 3,482–3,485 feet. Three months later and ¾ mile north, their Featherstone No. 1 came in with natural flow of 393 barrels daily from

3,586 to 3,600 feet. These wells are from the same 60-foot sand zone of the Strawn series that has produced oil on the Gray Ranch of northeast Coleman County since 1918. This Gray sand is correlated with the Lazy Bend formation or group of the Brazos River Valley section. It is about 140 feet below the Gardner producing sand of the Novice, North Novice, and Goldsboro fields which probably belong in the Grindstone Creek sand and shale formation. The names Silver Valley and Featherstone have both been applied to this new field but the latter is preferred on the basis of actual oil discovery and because of distance from Silver Valley. By the end of 1941, seven oil wells had been completed with total initial production of 2,777 barrels per day, some wells drilling as much as 50 feet of saturated sand.

The second important discovery occurred in September, being Merry Brothers and Perini's Greer No. 1, located 5 miles west of Novice. Initial flow was 22 barrels hourly from the Gray sand at 3,903–3,931 feet. Subsequent drilling also developed commercial production from the Morris sand at 3,400 feet in this area.

COOKE COUNTY

Two new oil fields were discovered during the year. The Texas Company's Bindle No. 1, 4½ miles northwest of Muenster, was completed, March 24, with initial production of 234 barrels daily from sand of Strawn age at a depth of 1,888–1,896 feet. Six additional wells were drilled in this pool. Two were completed from the 1,900-foot depth, three from the detrital Ellenburger at 3,300 feet, and one was dry.

Harvey Brothers and Gannon's Wilson No. 1, 5 miles east of Gainesville, opened a new pool from broken sands of Strawn age. This well was completed, June 19, from the sand at 2,216–2,227 feet with initial production of 77 barrels. Six additional producers were completed in this zone and three dry holes were drilled.

FISHER COUNTY

The McCaulley pool was discovered by the Stephenson Maberry No. 1 which made 151 barrels initially from a Cisco limestone from 3,310 to 3,333 feet on a seismograph structure. Four oil wells have been completed and the structure is not defined.

HASKELL COUNTY

The Lawson field was discovered in Haskell County, November 6, 1941. The discovery well was Lawson's Rose No. 1, producing initially 100 barrels of oil from a Canyon sand at 2,983–2,985 feet. The field was discovered by core testing.

JACK COUNTY

Most of the oil in Jack County has been produced from beds of the Strawn series. The latest development, resulting from geophysical prospecting, has tended toward deeper drilling with some promising results, and it is expected that many wells will be drilled to test the stratigraphic section into the Ellenburger limestone.

During the year several new wells produced oil either in new areas or in deeper formations of old producing fields. The northwest part of Jack County was given the most valuable discovery in what was termed the Hoefle pool discovery. Taubert-McKee and the Sinclair Prairie Oil Company's M. Hoefle No. 1, Sec. 14, A. James Survey, Abstract 318, produced from 4,817 to 4,835 feet in the Caddo limestone. This well tested 303 barrels of 43° gravity crude oil through a $\frac{3}{4}$-inch choke with a tubing pressure of 200 pounds and casing pressure of 600 pounds.

JONES COUNTY

The Wimberly pool was discovered by Hines' Wimberly No. 1 in limestone at 2,538–2,545 feet where it produced 100 barrels. It was drilled on a subsurface structure. Fourteen wells have been completed from four producing zones in the Cisco. The field covers at present approximately 640 acres and is not defined.

The South Noodle pool was discovered by the Humble Oil and Refining Company's Sears No. 2 in a Cisco sand at 3,008–3,012 feet, which produced 1,056 barrels initially. It was drilled on a subsurface structure. Four wells around a common corner have been completed and a dry hole defines production on the east.

PALO PINTO COUNTY

In Palo Pinto County gas is equally as important as oil, if not more important. There is sold from gas wells in the county more than 10 million cubic feet daily. Low pressure declines in the gas wells indicate that a considerable reserve of gas exists.

Only one new gas field was discovered during the year. This field was discovered by W. K. Gordon's Noland No. 1, Sec. 83, Block 3, T. & P. R.R. Company Survey. This well had an initial production of 1,185,000 cubic feet of gas from a depth of 4,352–4,362 feet. The extent of the producing area is not yet determined as there was only one well producing at the end of the year.

STEPHENS COUNTY

Two new discoveries were made. Orion A. Daniel *et al.* Max Blach No. 1, in the northwestern part of the county, was completed as a gas

distillate well in the Caddo limestone from 3,290 to 3,301 feet. It tested 89 barrels of 52° gravity oil and 3,750,000 cubic feet of gas per day. The total depth was 4,252 feet.

T. G. Shaw *et al.* Whalen No. 1, in the northeastern part of the county, Sec. 1089, T. E. & L. Company Survey, Abstract 370, was completed in a sand in the Big Saline at the depth of 4,077–4,095 feet. This test was drilled to the total depth of 4,706 feet in Ellenburger dolomite. The top of the Ellenburger was 4,645 feet and showed streaks of saturation along fracture planes to the total depth. The test was plugged back and completed in the Big Saline sand, gauging 10,500,000 cubic feet of wet gas through open tubing with 1,690 pounds tubing pressure.

A new producing sand was discovered in the Stroud pool. T. G. Shaw's Stroud No. 4 was completed in a Strawn sand 3,043–3,063 feet, flowing 126 barrels per day on a 42/64-inch choke. Previous production in this pool was from a Strawn sand at 2,500 feet.

TAYLOR COUNTY

The Merkel field was discovered by W. H. Peckham *et al.* F. & M. National Bank of Merkel No. 1, located 14 miles west of Abilene or 3 miles east of Merkel. Production was encountered at the depth of 2,013–2,019 feet in the Dothan limestone. This is a new producing zone. The initial production was 71 barrels by pumping. The gravity of the oil was 38°. The Dothan is of lower Wolfcamp or Permian age. The field was located by means of surface geology which was localized by core testing.

The Lewis Production Company's L. L. Huddleston No. 1 found the Dothan dry, but was drilled deeper, finding saturation at a depth of 2,622–2,626 feet in limestone identified as the Hope formation of upper Cisco or Pennsylvanian age. Initial production, 190 barrels on pump, 39° gravity. This well was completed, September 9, 1941. All other wells in the field are producing from this formation except the one well in the Dothan. Seven oil wells and two dry holes have been drilled in the field.

THROCKMORTON COUNTY

In the southeastern part of the county, 6 miles southeast of Throckmorton townsite, the Humble Oil and Refining Company's McKnight No. 1 opened a new Caddo pool, flowing 645 barrels of oil in 12½ hours through a ½-inch choke, following acid treatment with 5,000 gallons. However, the south offset, McKnight No. 2, was capable of producing only 27 barrels of oil and 73 barrels of water on the pump in 24 hours. Offsetting the McKnight No. 2 on the west, McKnight No.

3 was completed as a failure; and one mile northwest of the discovery well, Helmerich and Payne's Housley No. 1 also failed to produce commercially in the Caddo limestone.

Three miles south of the McKnight discovery and about 1½ miles west of the Parrott pool, the Humble Oil and Refining Company and R. F. Windfohr completed a Caddo limestone producer, Parrott No. 1, flowing 76 barrels of oil and 12 barrels of water in 24 hours through 2-inch tubing on the official test. To date no wells have been drilled offsetting this discovery.

WICHITA COUNTY

The Magnolia Oil Company's "Gladiolus" Burnett No. 79, an old well (old total depth, 1,936 feet), was deepened to the Ellenburger and produced initially 107.5 barrels of oil in 3 hours on ¾-inch choke from the top 8 feet of this formation.

Since the discovery of Ellenburger production in the K.M.A. area in April, 1940, there have been 116 wells drilled to the Ellenburger in the pool. Of these, 104 are flowing, 9 pumping (total of 113 producing), and 3 were dry holes. Most of these wells were drilled in 1941.

WILBARGER COUNTY

The Magnolia Petroleum Company's Fee No. 65, Sec. 17, Block 13, H. & T.C. R.R. Company Survey, was completed in the Ellenburger from 2,995 to 3,007 feet, producing 63.25 barrels through 3/16-inch choke. Two producers and two dry holes have been drilled in this pool.

The most important extension in this county during the year was in the Rock Crossing pool. The Phillips Petroleum Company's Bates No. 10 extended the Ellenburger production one mile west in this formation. Saturated dolomite was drilled from 3,804 to 3,815 feet, after the Ellenburger was found at 3,804 feet. The Fargo pool had continuous development throughout the year. Production was extended north, south, and west.

WISE COUNTY

The Hunt Oil Company's W. H. Halman No. 1, 5 miles north of Chico townsite, located on seismograph structure, tested the arkosic conglomerates and sands of the Bend. Several conglomerate lenses showed some oil stain. The most promising lens, cored from 5,667 to 5,675 feet, had fair oil saturation, but no permeability. A further drill-stem test yielded mud with a faint odor and a slight increase in bottom-hole pressure. The well reached the Bend limestone at 5,486 feet and was drilled to 6,015 feet, total depth.

Cranfill and Rodgers' McKay No. 1, 10 miles northwest of the town of Alvord, revealed the entire Bend section, from 5,585 to 6,610 feet, the Mississippian Barnett shale, from 6,610 to 6,840 feet, and the Viola-Simpson whose basal dolomites graded imperceptibly into typical Ellenburger. The best oil showings, in Bend arkosic conglomerates between 5,808 and 5,861 feet, were thoroughly tested. However, even after shooting, the well did not appear capable of producing more than a few barrels.

The Hunt Oil Company's T. B. Stack No. 1, a mile west of the town of Chico, located on seismograph structure, was drilled to 7,003 feet in the Ellenburger. The Bend section, from 5,217 to 6,490 feet, contained many arkosic conglomerates and quartzitic sands, tightly cemented, with faint stain and asphaltic residues. The Barnett shale was reached at 6,490 feet, and Ordovician dolomite, probably Ellenburger, from 6,887 to 7,003 feet. An interesting feature was the exceptional amount of lost circulation. These losses occurred in the lower Strawn sands, the conglomerates and sands of the Bend, and the Ordovician dolomite. Judged by the fractured nature of cores taken from 4,655 to 4,662 feet, from 5,702 to 5,706 feet, and from 6,896 to 6,914 feet, and the rough drilling with the circulation losses, the cause of the circulation losses appeared to be fracturing or minor faulting and not porosity or solution cavities.

YOUNG COUNTY

L. T. Burns on the Larimore land, south of Olney in T.E. & L. Company Survey No. 150, encountered the Chappel limestone structurally high, and penetrated it 100 feet before finding saturation. The well flowed high-gravity oil on drill-stem test and has maintained its original pressure since placed on production. Four other wells on the northwest, lower on structure, encountered saturation in the upper part of this limestone and produced less oil.

Another important discovery in the upper part of the Chappel limestone was T. D. Humphrey's Williamson well, south of Jean in T.E. & L. Company Survey No. 601. In this pool, three wells are now producing from the Chappel limestone.

As a result of deeper drilling, promising Strawn production was uncovered in the north half of the county near Loving and Jean, by the Kerlyn Oil Company, and by L. T. Burns in the area south of Olney. Heretofore, Strawn sand production was limited to the south half of the county.

CHILDRESS, COTTLE, KING, HARDEMAN, FOARD, AND KNOX COUNTIES

During the year 1941 there was very little activity in the western part of the Wichita Falls district covered by this report. Most of the limited development was in Foard County, where two deep Ellenburger wildcat tests were drilled, one dry hole on the north side of the Allee pool was drilled, and one well in the Johnson pool was deepened to granite. In Knox County only one fairly deep test and one shallow test, an offset to the deep one, were drilled. No wells were drilled in Childress, Cottle, King, or Hardeman counties.

WELLS DRILLED, 1941

County	*Oil*	*Gas*	*Dry*	*Oil Produced (1,000 Barrels)*
Archer	252	0	150	7,585
Baylor	26	0	12	564
Bosque	0	0	1	0
Brown	13	12	31	481
Callahan	30	5	69	366
Clay	258	1	131	1,538
Coleman	34	7	19	751
Comanche	15	0	14	97
Concho	0	0	1	0.3
Cooke	199	0	43	2,888
Denton	0	1	5	2.7
Eastland	17	3	15	756
Erath	0	0	1	0
Fisher	4	0	4	655
Foard	0	0	3	136
Grayson	0	0	0	7
Hamilton	0	3	6	0
Haskell	0	1	2	12
Hood	0	0	2	0
Jack	69	2	34	1,983
Jones	99	0	50	2,664
Knox	0	0	3	0
Lampasas	0	0	1	0
McCulloch	0	0	3	0
Mills	0	0	2	0
Montague	87	1	31	2,713
Nolan	0	0	1	0.5
Palo Pinto	3	1	14	101
Parker	0	0	3	0
Runnels	1	0	2	40
San Saba	0	0	1	0
Shackelford	70	1	87	2,131
Stephens	10	5	6	1,212
Stonewall	0	0	6	41
Tarrant	0	0	2	0
Taylor	15	3	17	128
Throckmorton	58	1	23	181
Wichita	438	0	119	15,702
Wilbarger	77	0	27	2,811
Wise	0	0	3	0
Young	197	6	183	3,839
Total	1,972	53	1,130	49,534

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1050–1057, 1 FIG.

DEVELOPMENTS IN EAST TEXAS DURING 1941[1]

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ABSTRACT

The marked increase in exploratory tests in East Texas during 1941 resulted in the discovery of three oil fields. Two of these fields are producing from the Woodbine formation and one from the Rodessa zone of the lower Glen Rose formation.

In the Hawkins field, which was the major 1940 discovery, a rapid development program took place and 243 oil wells, 3 gas wells, and 8 dry holes were drilled.

The number of completions in other proved fields exceeded that of 1940.

INTRODUCTION

The East Texas area (Fig. 1) experienced an increase in activity during 1941 which resulted in the drilling of almost twice as many wells as were drilled in 1940. This increased activity was reflected in both field and wildcat drilling. In all, 1,145 wells were drilled during the year as compared with 659 in 1940. A classification of the wells drilled during the two years is as follows.

	1940	*1941*
Oil wells	485	891
Gas and distillate wells	60	52
Dry holes (fields)	42	74
Dry holes (wildcats)	72	128
Total	659	1,145

Developments in nearly all fields were in general routine with a notable exception at Hawkins where an important extension of production on the east flank of the structure was effected. Abandonments in the East Texas field again exceeded completions although this field together with Hawkins accounted for the major share (728) of the oil wells listed.

NEW FIELDS AND PRODUCING AREAS

East Long Lake (*Anderson County*).—The East Long Lake producing area is 1½ miles east of the northern part of the Long Lake field. Production was established at East Long Lake on April 17, 1941, when "Tex" Harvey Oil Company's S. E. Cartmel No. 1 was completed from perforations at 5,370–5,374 feet in the Woodbine formation, flowing 365 barrels of 42.8° gravity oil per day through a ¼-inch tubing choke. Gas-oil ratio was 3,156 to 1. At the close of the year the field had 11 oil wells, 2 dry holes, and 1 well was drilling.

[1] Presented by title before the Association at Denver, April 22–24, 1942. Manuscript received, May 5, 1942.

[2] Consulting geologists, Owen Building.

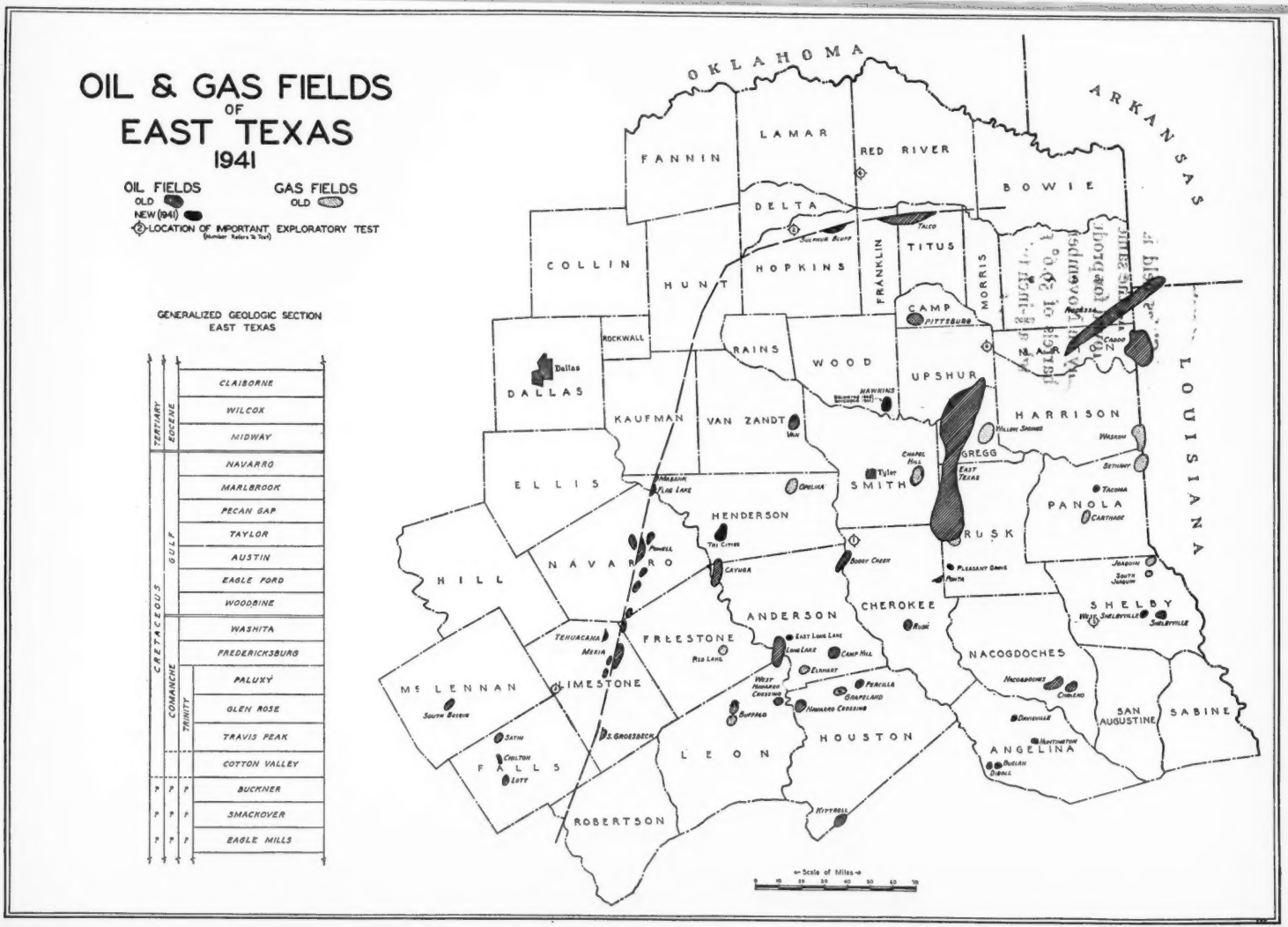
OIL & GAS FIELDS
OF
EAST TEXAS
1941
OIL FIELDS
OLD
NEW (1941)
GAS FIELDS
OLD
LOCATION OF IMPORTANT EXPLORATORY TEST
GENERALIZED GEOLOGIC SECTION
EAST TEXAS
TERTIARY
EOCENE
CLAIBORNE
WILCOX
MIDWAY
GULF
CRETACEOUS
COMANCHE
TRINITY
NAVARRO
MARLBROOK
PECAN GAP
TAYLOR
AUSTIN
EAGLE FORD
WOODBINE
WASHITA
FREDERICKSBURG
PALUXY
GLEN ROSE
TRAVIS PEAK
COTTON VALLEY
BUCKNER
SMACKOVER
EAGLE MILLS
OKLAHOMA
ARKANSAS
LOUISIANA
FANNIN
LAMAR
RED RIVER
BOWIE
DELTA
COLLIN
HUNT
HOPKINS
FRANKLIN
TITUS
MORRIS
CAMP
ROCKWALL
RAINS
WOOD
UPSHUR
DALLAS
KAUFMAN
VAN ZANDT
HARRISON
GREGG
ELLIS
SMITH
HENDERSON
RUSK
PANOLA
HILL
NAVARRO
ANDERSON
CHEROKEE
SHELBY
FREESTONE
NACOGDOCHES
MCLENNAN
LIMESTONE
SAN AUGUSTINE
SABINE
HOUSTON
ANGELINA
FALLS
LEON
ROBERTSON
Scale of Miles
0 10 20 30 40 50 60 70

FIG. 1

Tri-Cities (*Henderson County*).—The Tri-Cities field is approximately 7 miles southwest of the town of Athens and the same distance northeast of the Cayuga field. The area was proved for production by the British-American Oil Producing Company on November 13, 1941, when its M. G. Young No. 1 flowed 355 barrels of 59.6° gravity oil and 31 barrels of salt water in 24 hours through a $\frac{3}{8}$-inch tubing choke. This production is from perforations at 7,608–7,641 feet in the uppermost part of the Rodessa porosity of the lower Glen Rose.

This well was located on a subsurface and geophysical prospect. There has been no further development in the area since the completion of the discovery well.

Pleasant Grove (*Rusk County*).—L. O. McMillan's J. F. Pool No. 1, located $4\frac{1}{2}$ miles northeast of New Salem and 5 miles south of the southern end of the East Texas field, was completed on July 29, 1941, opening a new Woodbine producing area which has been designated the Pleasant Grove field. The completion gauge showed 215 barrels of 39.4° gravity oil in 24 hours with a gas-oil ratio of 560 to 1.

This well is located on the downthrown side of a fault, and the accumulation apparently occurs in the truncated edge of the Woodbine sand which in this area is directly overlain by the Austin chalk. At the close of the year this field contained 4 producers, 4 dry holes, and one well was drilling.

FIELD DEVELOPMENTS

Caddo (*Marion County*).—In the Caddo field, 29 wells were drilled during 1941. Of this total, 16 were oil wells and 13 were dry holes. The high ratio of dry holes to oil wells discouraged drilling in this field during the year, and the number of new wells was considerably lower than in 1940 when a total of 45 wells was drilled. Oil is produced from the Blossom sand which is encountered at an average depth of 2,350 feet.

Carthage (*Panola County*).—Drilling activity in the Carthage field was renewed in 1941 and 3 gas-distillate wells were completed in the Rodessa section of the lower Glen Rose. This field, which is high on the southwest flank of the Sabine uplift, also produces gas-distillate from the Pettit zone and now contains 9 producing wells.

Cayuga (*Anderson, Henderson, and Freestone counties*).—During 1941 the Cayuga field experienced a slight decrease in activity compared with that of the previous year. Completions in the Woodbine numbered 15 oil wells, 4 gas-distillate wells, and 1 dry hole. In addition, 2 gas-distillate wells were completed in the Rodessa limestone of the lower Glen Rose.

On January 1, 1942, there were 282 oil wells and 50 gas wells producing from the Woodbine formation and 6 gas-distillate wells producing from the Rodessa section. Cumulative Woodbine oil production from this field to the beginning of 1942 was 22,280,000 barrels.

Chapel Hill (*Smith County*).—The entrance of additional major operators in this field during 1941 led to increased drilling and during the year 11 Pettit oil wells and 3 Rodessa-Pettit gas wells were completed. In the course of this drilling the area proved for shallower Paluxy gas-distillate production was extended northwestward and it now appears that approximately 2,300 acres have been proved for production from this formation.

As of January 1, 1942, the Rodessa formation had yielded 458,000 barrels of distillate and the Pettit 95,000 barrels of distillate and 215,000 barrels of oil. Cumulative Paluxy distillate production to the same date was 75,000 barrels.

East Texas field.—Although drilling activity in the East Texas field exceeded that of 1940 by a substantial margin, the number of wells (619) abandoned was greater than the new completions (485). The 25,800 producing wells as of January 1, 1942, are classified as follows in comparison with those of the previous year.

	1940	*1941*
Flowing	17,735	17,330
Gas kick-off	87	100
Gas lift	916	979
Pumping	7,174	7,132
Dead	23	259

Fault-line fields.—During 1941, 25 wells were drilled in the old fault-line Woodbine fields, for example, Currie, Powell, and Wortham, lying principally in Navarro County. These resulted in small pumping wells capable of 20–70 barrels of oil per day with varying amounts of salt water.

Flag Lake (*Henderson and Navarro counties*).—There was no additional drilling in the Flag Lake field during 1941. At the close of the year 4 wells had been abandoned and the field listed 17 Woodbine producers, 13 of which were showing water. Cumulative production to January 1, 1942, was 652,000 barrels of oil.

Grapeland (*Houston County*).—The level of drilling activity at Grapeland approximated that of 1940 with 12 Woodbine gas-distillate completions compared with 15 the previous year. By January 1, 1942, there were 35 gas-distillate wells and 1 oil well in this field, where recycling operations are currently in progress. Cumulative distillate production to the same date was 3,360,000 barrels.

Hawkins (*Wood County*).—A drilling boom at Hawkins, following

the discovery of this major Woodbine field late in 1940, resulted in 243 oil wells, 3 gas wells, and 8 dry holes during 1941. Only 2 wells had been drilled in the field prior to the beginning of 1941. Rapid development in the Hawkins townsite led to the drilling of 87 wells in that part of the field. Subsurface information afforded by this extension drilling confirmed the presence of a large and complexly faulted structure with probably more than 900 feet of closure on the top of the Woodbine formation.

One flank location was drilled to the Paluxy formation but it resulted in a dry hole.

The field produces an average of 11,000 barrels daily and the cumulative production to January 1, 1942, was 1,436,000 barrels.

The Humble Oil and Refining Company now has two pipe lines into the field, a 6-inch and an 8-inch, with a combined daily capacity of 40,000 barrels. Roger Lacy has laid a 1,500-barrel-daily-capacity 4-inch pipe line to his refinery at Kilgore.

Joaquin (*Shelby County*).—In the Joaquin field 6 gas-distillate wells were completed in the Rodessa limestone during 1941. One of these wells, Grady Vaughn's Pickering Lumber Company No. 1, was drilled to the Travis Peak and tested gas-distillate in that formation but was plugged back and completed as a producer in the Rodessa section.

Long Lake (*Anderson, Freestone, and Leon counties*).—A slight increase in drilling activity in the Long Lake field during 1941 resulted in the completion of 37 oil wells and 5 gas-distillate wells in the Woodbine. This compares with a total of 37 completions for the preceding year. The cumulative production for the field at the close of 1941 was 3,142,000 barrels.

Navarro Crossing (*Houston County*).—Only one oil well was completed in the Navarro Crossing field during 1941. The cumulative production in this Woodbine field to January 1, 1942, was in excess of 582,000 barrels.

Opelika (*Henderson County*).—The Lone Star Gas Company has completed the erection of a recycling plant in the Opelika field with a daily capacity of 85 million cubic feet. During the year 5 gas-distillate wells were completed in the Rodessa limestone and 1 dry hole was drilled. There are now 10 producing wells in the field and the cumulative distillate production to January 1, 1942, was 1,570,000 barrels.

Pittsburg (*Camp County*).—Two oil wells were completed during the year in this field, which produces from an updip sand facies of the Pettit section of the basal part of the lower Glen Rose at depths approximating 8,000 feet. Two additional wells were drilling at the end

of the year. Development in this field has been slow due to high drilling costs and a hard sandstone reservoir with low permeability which results in small initial production and requires expensive methods of completion.

At the close of 1941 the field contained 3 wells and had a cumulative production of 45,700 barrels.

South Groesbeck (*Limestone County*).—One high-ratio oil well was completed in this field during the year which, added to the 3 previously completed gas-distillate wells, brings the total number of producers in the field to 4. Production in this field is from the Pettit limestone which is encountered at an approximate depth of 5,650 feet.

Talco (*Titus and Franklin counties*).—The Talco field experienced a decrease in drilling activity during 1941 with 42 oil well completions as compared with 53 the previous year.

This field now lists a total of 756 producing wells all of which are on the pump. This production is obtained from the Paluxy formation and is a heavy asphaltic oil. As of January 1, 1942, the field had produced a total of 48,160,000 barrels.

Van (*Van Zandt County*).—In the Van field 5 oil wells were completed during 1941, extending the producing area to the northeast, and the field now contains 564 oil wells producing from the Woodbine. This large faulted structure also produces minor amounts of oil from the shallow Nacatoch formation which is encountered at a depth of about 1,200 feet. The cumulative production for the field to January 1, 1942, was 128,949,000 barrels.

Willow Springs (*Gregg County*).—The addition of 3 gas-distillate wells in the Willow Springs field during the year brought the total to 7 producers. Of these 3 new wells, 2 produce from the Pettit and 1 from the Rodessa and Pettit. One dry hole was also drilled during the year. A recycling plant with a daily capacity of 50 million cubic feet was completed during the year.

IMPORTANT EXPLORATORY TESTS

Cherokee County.—The Larissa area, in northwestern Cherokee County, was condemned for Woodbine production when Bobby Manziel's Limberlog School No. 1 (*1*),[3] was abandoned August 29, 1941, at the total depth of 5,230 feet after testing salt water in the Woodbine formation. This well was the third Woodbine well that Manziel had drilled in the Larissa area during the year. Even though no showings were encountered in the Woodbine in any of these wells, they confirmed the presence of a structure which is reflected in the

[3] Italic numerals in parentheses refer to numbers in Figure 1.

surface formations and outlined on the deeper horizons by seismograph work in the Larissa area.

Hopkins County.—The W. B. Hinton and Talco Asphalt and Refining Company's S. M. Long No. 1 (*2*), in the Peerless area in north-central Hopkins County, approximately 11 miles west of the Sulphur Bluff field, was plugged and abandoned, December 31, 1941, at the total depth of 4,851 feet after pumping up to 8 barrels of heavy black oil per day with a large amount of salt water from perforations from 4,740 to 4,748 feet opposite the Paluxy formation.

This well was located on a fault which cut out several hundred feet of Washita-Fredericksburg section. The top of the Paluxy was encountered at 4,729 feet and the first good sand at 4,740 feet. The elevation was 518 feet.

Limestone County.—The Farrell Drilling Company's J. R. Gillam No. 1 (*3*), in western Limestone County, about 3 miles east of the town of Mart, was dry and abandoned in schist, October 14, 1941, at the total depth of 4,865 feet. In this well, with an elevation of 523 feet, the anhydrite was encountered at 3,245 feet, the Travis Peak at 3,715 feet, and the schist at 4,790 feet. This well had no showings of either oil or gas but it is significant in that it limits the possible westward extension of the Smackover limestone in that area.

Red River County.—The Magnolia Petroleum Company's J. M. Henry No. 1 (*4*), in western Red River County, reached the total depth of 4,789 feet in the Paleozoic quartzitic sandstone and slaty shale lying directly beneath the Travis Peak formation. The Paleozoic was encountered at approximately 4,425 feet. This well was abandoned as a dry hole on October 14, 1941, and no showings were encountered. It was drilled on a large block of leases which Magnolia had mapped by gravity, seismograph, and core drill. This well is located only 16 miles north of the Talco fault and helps to establish a north boundary for the belt along which the Smackover limestone may be present as a continuation westward from the southern Arkansas fields.

Shelby County.—Grady Vaughn's Frost Lumber Company No. 1 (*5*), located 3 miles north of the village of Arcadia in southwestern Shelby County, was abandoned as a dry hole on December 18, 1941, after testing salt water and a small amount of gas in the Rodessa section of the lower Glen Rose. The top of the Rodessa porous section was encountered at 6,373 feet and the base at 6,563 feet with about 110 feet of net porosity in this interval. Porous limestone with a stain and odor of light oil was included in core recoveries but repeated efforts to complete this well as a producer were unsuccessful. Largely as a result of the showing of oil in Rodessa cores this well was drilled

to the Travis Peak, the top of which was found at 7,810 feet, but no further showings were encountered. The final total depth was 8,243 feet.

Upshur County.—The Sun Oil Company's W. C. Henderson No. 1 (*6*) was abandoned as a dry hole on April 23, 1941. This well is located in northeastern Upshur County on the southeast flank of a broad structure indicated by previous drilling. It reached a total depth of 7,923 feet and no showings were reported except for a minor showing of brown, apparently "dead" oil in a core of sandy shale taken in the Travis Peak. Porosity was poorly developed in the Rodessa, Pettit, and Travis Peak and no tests were made in this well.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1058-1072. 2 FIGS.

DEVELOPMENTS IN OKLAHOMA DURING 1941[1]

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ABSTRACT

Oklahoma's position improved during 1941 by increasing production about 2¼ million barrels to total 152,013,942 barrels. Estimated reserves, according to the American Petroleum Institute, at the close of 1941 were 1,035,820,000, an increase of 34 million barrels over 1940. The Oklahoma production curve paralleled the national production curve from 1930 through 1937. The drop in national production in 1938 was corrected in 1939 and national production has continued to rise since that year. Oklahoma production, on the other hand, steadily declined through 1938, 1939, and 1940. The small gain in production and reserves in 1941 is the first hopeful sign in several years. Production increase is due largely to development of pools discovered prior to 1941. However, 41 new pool discoveries are listed for the year. Of these Apache is the most important, but its discovery came too late in the year materially to affect production. An encouraging sign is the continued successful search for oil in the older areas such as the Seminole region and Okfuskee County.

Geophysical activity was widespread and included all the present-day methods. There was an average of 25 seismograph parties operating in the state, totaling 281½ crew months of work, an increase of 36 crew months for the year. More than half of the new discoveries are credited to seismograph surveys. Gravimeters and magnetometers continued in use and the stratigraphic drill was used more than in previous years.

There were 2,162 wells drilled during the year, of which 1,489 produced oil or gas. Of these, 271 were exploratory wells drilled following the exploratory surveys. Eighty-one of these wells were completed as producers, and 41 are classed as new pool openers.

INTRODUCTION

Oil in commercial quantities is produced in twenty-three states of the Union, but 81 per cent of all production for 1941 came from five states. Oklahoma ranks third in these states. Texas, California, Oklahoma, and Louisiana increased their 1941 production over 1940. Illinois alone of the "big five" decreased.

There were 2,162 wells drilled in Oklahoma during 1941, 69 per cent of which produced oil or gas. Of the 2,162 wells drilled, 271, or 12.5 per cent, were exploratory tests and 81 produced oil or gas. It is an encouraging sign that both the annual production and the estimated reserves increased during the past year.

PRODUCTION

For the first time since 1937 the yearly production of Oklahoma increased. Total production of 152,013,942[3] barrels for 1941 is ap-

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, April 13, 1942.

[2] The Pure Oil Company.

[3] Production figures are based on the 1941 production report of the Oklahoma Corporation Commission.

proximately 2¼ million barrels, or 1.4 per cent above the 1940 production of 149,725,073 barrels. There were 2,162 new wells drilled, compared with 2,147 wells drilled in 1940. Oil is produced in 42 of Oklahoma's 77 counties. In sixteen counties an increase over 1940 production was registered, while in 26 counties declines were noted. Nearly 60 per cent of all the oil produced in Oklahoma in 1941 came from five counties, all of which produced in excess of 10 million barrels.

TABLE I

COMPARATIVE TABLE OF COUNTIES PRODUCING TEN MILLION BARRELS OR MORE

County	*1941*	*Percentage of 1941 Total*	*1940*	*Percentage of 1940 Total*
Oklahoma	33,450,191	22.0	37,476,542	25.0
Seminole	21,620,230	14.2	23,141,176	15.5
Pottawatomie	12,141,868	8.0	12,192,407	8.1
Osage	11,951,936	7.9	11,512,479	7.7
Carter	10,260,520	6.8	7,671,568	5.1
	89,424,745	58.9	91,994,172	61.4

Oklahoma County production declined 10.8 per cent, but still easily leads the production list with 33,450,191 barrels. Counties in which 1941 production increased over 1940 lie chiefly in the northern and southern parts of the state, while as a whole, the counties through the central part of the state declined. Production increases in the northern part of the state are due in the main to reconditioning wells, deeper drilling, plug back, *et cetera*. The chief area of new oil and important increases is in the southern and southwestern parts of the state. Six of the seven counties which increased their production more than 50 per cent are in this area. The production from Marshall and Bryan counties (combined) increased nearly 2 million barrels, due almost entirely to the development of the Cumberland pool. Carter County registered an increase of nearly 3 million barrrels, chiefly due to additional development in the West Hewitt pool. Kiowa County increased its production 2,310 per cent, or from 36,000 barrels to nearly 900,000 barrels, due to the continued development of the Hobart pool. Caddo County registered an increase of nearly a million barrels, due in part to an increase in the daily allowable at Cement, and to the steady development of the Apache pool.

Figure 1 shows the producing counties in Oklahoma and their percentage of increase or decrease from 1940 production. Figure 2 shows the relation of Oklahoma's production to the total United States production from 1930 to 1941, inclusive.

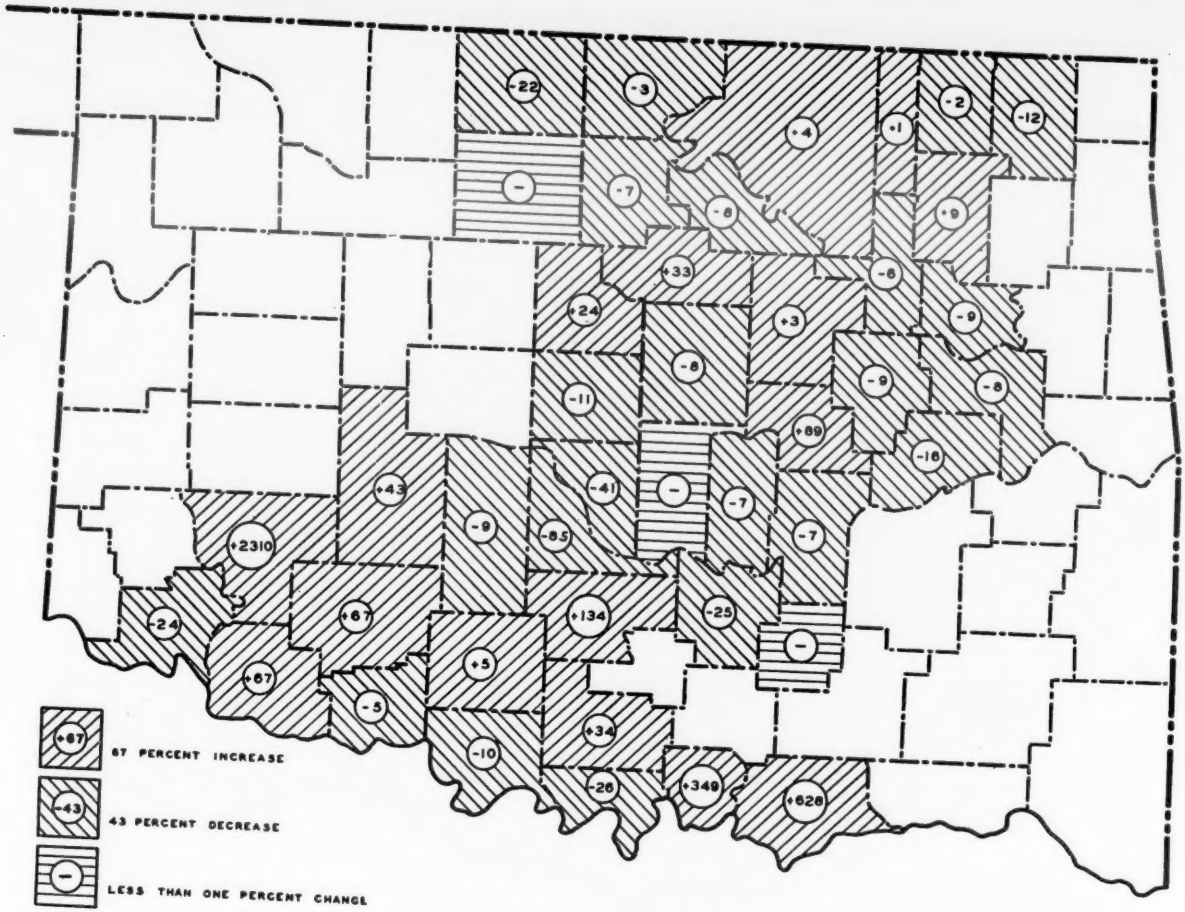

FIG. 1.—Map showing counties in Oklahoma which produced oil in 1941 and percentage of increase or decrease from 1940 production.

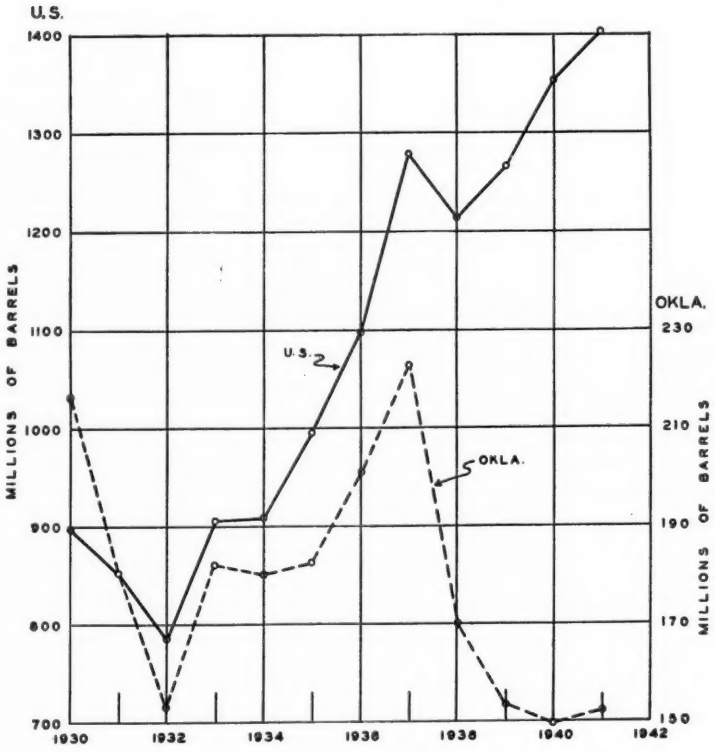

FIG. 2.—Graph showing relation of Oklahoma production to national production from 1930 to 1941.

TABLE II

WELLS DRILLED 1941

	Total	*Oil*	*Gas*	*Dry*	*Initial Production*
New wells	1,930	1,169	154	607	359,101
Deepened	200	159	7	34	35,649
Input wells	22				
Disposal	10				
	2,162	1,328	161	641	394,750
Percentage		61.5	7.4	29.6	
1940	2,147	1,225	182	740	304,356
Percentage		57.0	8.5	34.5	

DRILLING OPERATIONS

The total number of wells drilled in 1941 is practically the same as in 1940. The percentage of oil wells increased 4.5 per cent, while the percentage of dry holes decreased 4.9 per cent. Approximately 5,780,000 feet of hole were drilled in the 2,162 wells, for an average depth of 2,673 feet. No 10,000-foot holes were completed, although two wells were drilling below this depth at the close of the year.

METHODS OF EXPLORATION

Methods employed in the search for oil include practically everything except the "wiggle stick." Seismograph and subsurface are the high-ranking ones, but gravimeter, magnetometer, electrical resistivity, soil analysis, core drilling, stratigraphic or "slim-hole" drilling, and surface work were all employed.

There were twenty-four seismograph parties operating in Oklahoma the first of the year, and twenty-six parties as the year closed,

TABLE III

SUMMARY OF EXPLORATORY WORK DURING 1941

Type	*Amount of Work*	*Number of Companies*
Seismograph	281½ crew months	25 approx.
Core drill	227 holes	3
Stratigraphic drill	25 holes	3
Gravimeter	75½ crew months	10
Magnetometer	20½ crew months	3
Soil analysis	6 crew months	3
Electrical resistivity	4¾ crew months	2
Surface	7¾ crew months	3

working a total of 281½ crew months. About 85 per cent of this work was for major companies. The general Seminole area was carefully worked over, with most of the other activity in southwestern, western, and northwestern (including the Panhandle) parts of the state. Of the eighty-one discoveries listed for the year, seismograph is credited with the discovery of forty-three.

Table III gives a summary of the exploratory work during the past year. Obviously subsurface work can not be included in this table.

DISCOVERIES

The search for new oil in Oklahoma continues to be successful. Table IV lists 81 successful exploratory operations completed in 1941. These include 41 new pools, 27 new producing formations, and 13 extensions. Most of these operations are of little importance for additional development. Only 6 of the total of 81 successful exploratory

TABLE IV

New Pools—Extensions and New Zones Discovered during 1941

County	Section Township, Range	Field	Class	Operator	Farm	Month, Day, Year	Producing Formation	Depth in Feet	Total Depth	Plugged-Back Depth	Initial Production	Development
Kay	16-28- 1W	S. E. Braman	N.Fm.	Tidewater	State	1- 2-41	Arbuckle	3,640	3,665		Fl. 512 oil; 15 water	1 oil
Kay	19-28- 1E	Dilworth	Ext.	McKnabb	Warren	9-15-41	"Wilcox"	3,336	3,358		Fl. 27	2 oil; 5 drlg.
Kay	29-28- 1E	Dilworth	Ext.	Nat'l. Union	Long	3- 4-41	"Wilcox"	3,372	3,378		P. 83	3 oil
Osage	18-24- 8E	Kasishke	Ext.	Dunn & Miller	Osage	5-20-41	Hominy	2,796	2,845		100	
Osage	34-22- 7E		New	Devonian	Osage	10-23-41	Hominy	3,025	3,065		200	
Noble	16-22- 1E	Otoe	New	Superior	Faubian	6-21-41	"Wilcox"	4,728	4,925	4,765	Fl. 312	2 oil; 2 dry
Pawnee	1-21- 5E	E. Pawnee	New	Alma	Hill	1-14-41	Misener	3,363	3,369		Fl. 500 oil; 600 water	1 oil; 2 dry
Pawnee	25-20- 6E		New	Sand Springs Home	Launer	7-22-41	"Miss. lime"	3,105	3,274	3,152	P. 10	1 oil
Payne	12-19- 1W	E. Orlando	New	Gardner	Lowry	5-19-41	Misener	4,720	4,747		Fl. 177	2 oil; 1 dry
Payne	13-18- 3E	NE. Mehan	New	Berry	Berry	8- 4-41	2d "Wilcox"	4,100	4,103		Fl. 167	2 oil; 1 drlg. 1 dry
Creek	34-17- 8E	N. Bristow	New	Zephyr	Sinclair	8-11-41	Prue	2,325	3,692	2,733	P. 73	3 oil
Creek	34-17- 8E	N. Bristow	N.Fm.	Zephyr	Bishop "B"	11-17-41	Red Fork	2,716	2,772	2,740	P. 55 oil in 14 hours	2 oil
Creek	16-15- 7E	N. Milfay	New	Deep Rock	Meadors	12-10-41	2d "Wilcox"	3,950	3,985		Fl. 134 oil	1 oil
Creek	32-15- 7E	E. Stroud	N.Fm.	Lewis	Jones	4-14-41	Prue	2,830	4,102	2,850	Fl. 105	35 oil
Creek	7-15- 8E	Depew	Ext.	Balph	Starr	9- 1-41	"Wilcox"	3,792	3,817		Fl. 200	3 oil
Creek	26-14- 7E	W. Arno	N.Fm.	H. F. Wilcox	Sootkey	7-29-41	Bartlesville	3,157	3,615	3,180	Fl. 50	4 oil
Creek	34-14- 7E	W. Arno	N.Fm.	Bryan	Deere	4-28-41	"Wilcox"	3,967	4,020	3,975	P. 100	2 oil
Creek	35-14- 7E	W. Arno	N.Fm.	H. F. Wilcox	Stephney	5-26-41	Red Fork	2,900	4,011	2,940	Fl. 100	1 oil
Logan	7-17- 1W	Guthrie	New	Hamilton *et al.*	Donoghue	3-14-41	2d "Wilcox"	5,425	5,445		Fl. 2,444	25 oil
Logan	12-17- 2W	Guthrie	N.Fm.	Sunray	McLeod	9-29-41	Bartlesville	5,109	5,505	5,175	Fl. 120	5 oil
Logan	17-15- 3W	Navina	New	Continental	Leniger	7-15-41	"Wilcox"	6,219	6,422	6,250	Fl. 105 oil	1 well
Lincoln	29-15- 5E	N. Davenport	New	Dunnett	Luckenbill	9- 8-41	Prue	3,504	3,550	3,548	P. 43 oil	6 oil; 1 drgl. 2 dry
Lincoln	31-14- 6E	W. Peck	New	Mid-Continent	Evans Land	10-19-41	Hunton	4,543	4,842		A.P. 122 oil; 216 water	1 oil
Lincoln	20-13- 6E	Laffon	Ext.	Big Chief	Barrett	11-23-41	Hunton	4,185	4,449	4,260	A. 13 M. gas	1 gas
Lincoln	25-13- 6E		New	Allied Material	Hicks	8-25-41	Hunton	4,978	4,312		A. 6½ M. gas	1 gas
Oklahoma	17-14- 2W		New	Harper-Turner	Harper	10-18-41	Bartlesville	5,882	5,906		Fl. 35 oil	4 oil
Oklahoma	33-14- 2W		New	Harper-Turner	Kune	9-17-41	Bartlesville	5,819	6,132	5,870	Fl. 36 oil	1 oil
Okmulgee	6-13-11E	SW. Nuyaka	N.Fm.	Vincent	West	6- 9-41	Misener	3,168	3,176		Swb. 100	1 oil; 1 dry
Okfuskee	15-12- 9E	Mason	New	Texas	Butcher	5-20-41	Cromwell	3,310	4,048	3,323	Fl. 57 oil	3 oil; 2 dry
Okfuskee	36-12- 9E	N. Okemah	New	Henry	Dudgeon	1-21-41	Gilcrease	3,055	3,297	3,113	Fl. 669	3 oil
Okfuskee	7-11- 8E	Rusk	New	Malernee	Beard	9- 8-41	Cromwell	3,696	3,710		Fl. 748	8 oil; 1 dry
Okfuskee	22-11- 8E	S. Dill	New	Shell	Keys "B"	8- 4-41	Hunton	4,084	4,371	4,235	Fl. 750 oil	4 oil
Okfuskee	26-11- 8E	E. Cromwell	N.Fm.	Shell	Smith	5- 3-41	2d "Wilcox"	4,224	4,242	4,237	Fl. 151 oil; 7 water	1 oil
Okfuskee	36-11- 8E	E. Cromwell	Ext.	Titus	Canaday	8- 4-41	Cromwell	3,442	3,447		Fl. 10	1 oil
Okfuskee	6-11- 9E	Castle	New	K.G.F.F.	Camp	3-29-41	Hunton	3,914	4,010		Fl. 195	2 oil; 1 dry
Okfuskee	17-11- 9E	S. Castle	New	Shell	Heffner	9- 8-41	Hunton	3,872	4,127		Fl. 481 oil in 13 hours	3 oil
Okfuskee	20-11- 9E	W. Okemah	New	Deep Rock	Davis	1-27-41	Hunton	3,871	4,192	3,986	A. Fl. 83 oil	6 oil
Okfuskee	3-11-10E	E. Okemah	Ext.	Shelton	Armstrong	7-28-41	Cromwell	3,260	3,394		P. 35 oil in 10 hours	1 oil; 1 dry
Okfuskee	14-11-10E	E. Okemah	New	Alma	Replogle	6-30-41	Cromwell	3,193	3,215		Fl. 40 oil; 356 water	3 oil; 1 dry
Okfuskee	15-11-10E	E. Okemah	Ext.	Droppleman	Yahola	12- 3-41	Cromwell	3,147	3,946	3,171	3½ M. gas	1 gas
Okfuskee	6-10- 9E	N. Bearden	N.Fm.	Shell	Palmer	10-27-41	Booch	2,954	4,215	3,154	A.P. 34 oil	2 oil; 3 drlg.
Seminole	28-10- 8E	S. Cromwell	N.Fm.	Sinc. Prairie	Yahola	5-21-41	Wapanucka Cromwell	3,440	4,357	3,600	Fl. 87 oil; 450 water	1 oil
Seminole	11-10- 7E	Sylvan	New	Stanolind-Amerada	Buck	11- 7-41	"Wilcox"	4,368	4,435	4,404	P. 102	1 oil; 1 dry
Seminole	25-10- 7E	N. Bethel	Ext.	Winona	Brown	7-21-41	Cromwell	3,567	3,579		Fl. 310	3 oil
Seminole	33-10- 8E		New	Mico	Kidd	9- 1-41	Senora	2,145	3,767	2,160	P. 40 oil	2 oil

TABLE IV (*Continued*)

County	Section, Township, Range	Field	Class	Operator	Farm	Month, Day, Year	Producing Formation	Depth in Feet	Total Depth	Plugged-Back Depth	Initial Production	Development
Seminole	22- 9- 5E	W. Earlsboro	N.Fm.	Thompson	Anderson	10-27-41	Earlsboro	3,435	3,456		Fl. 215	4 oil
Seminole	14- 9- 7E	W. Bethel	N.Fm.	McIntyre	Brown	4-23-41	Cromwell	3,451	4,337	3,550	Fl. 162 oil; 240 water	5 oil; 1 dry
Seminole	29- 8- 6E		New	Donmar	Smith	12-22-41	Hunton	4,354	4,619		A.P. 45	1 oil
Seminole	30- 8- 7E	N. Little River	N.Fm.	Delaney	Harjo	5-27-41	Hunton	4,150	4,170		Fl. 323 oil	3 oil
Seminole	30- 8- 7E	N. Little River	New	Delaney & Atlantic	Clark	2- 1-41	"Wilcox"	4,272	4,289		Fl. 100	2 oil; 1 dry
Seminole	4- 8- 8E	Sheppard	New	Alma	Borden	3-11-41	Cromwell	3,290	4,323	3,350	Fl. 25 oil; 10 water	2 oil
Seminole	8- 8- 8E		New	Hall & Jordan	Jennings	9- 1-41	Hunton	3,965	4,285		A. Fl. 87 oil; 43 water	1 oil
Seminole	16- 8- 8E	NE. Wewoka	N.Fm.	Magnolia	Davis	4-30-41	Hunton	3,940	4,282		A. Fl. 23 oil; 10 water	3 oil; 1 dry
Seminole	14- 7- 7E	W. Fish	New	Hall	Jackson	3- 4-41	Booch	3,168	3,192		P. 44 oil	1 oil; 2 dry
Seminole	28- 7- 7E		New	Keener	Homestake	9-16-41	Senora	2,125	2,164	2,138	P. 25 oil	1 oil; 1 dry
Seminole	19- 7- 8E	Fish	Ext.	Mid-Continent	Ferguson	3-24-41	Calvin	1,478	3,491	1,536	P. 335	13 oil; 3 dry
Pottawatomie	36-10- 3E	Tecumseh Lake	New	Hall-Jordan	Whitehead	4-22-41	"Wilcox"	5,234	5,245		Fl. 2,625	12 oil
Pottawatomie	13- 9- 4E	Hotulke	Ext.	Anderson-Prichard	Hood	4-28-41	Hunton	4,122	4,152		A. Fl. 240	3 oil
Pottawatomie	16- 9- 4E	E. Tecumseh	New	Atlantic & Crosbie	Schoolland	6- 3-41	Viola	4,580	4,722	4,651	A. Fl. 651	8 oil; 1 dry; 1 drlg.
Pottawatomie	16- 9- 4E	E. Tecumseh	N.Fm.	Atlantic & Crosbie	Lee	12-15-41	2d "Wilcox"	4,838	4,850		P. 198 oil; 24 water	1 oil
Pottawatomie	21- 9- 4E	W. Hotulke	New	Sharp	Billington	7-14-41	Viola	4,490	4,640	4,597	A.P. 500 oil; 160 water; 36 hours.	5 oil
Pottawatomie	22- 9- 4E	W. Hotulke	N.Fm.	Atlantic	Higbee	9- 1-41	2d "Wilcox"	4,629	4,647		P. 593	7 oil
Pottawatomie	22- 9- 4E	W. Hotulke	Ext.	Smith & Sunray	Billington	9- 8-41	"Wilcox"	4,429	4,445		P. 256 oil; 200 water	2 oil
Pottawatomie	25- 9- 4E	Hotulke	N.Fm.	Sun	Kessinger	10-13-41	Hunton	4,151	4,435		Fl. 480 oil	1 oil; 1 drlg.
Pottawatomie	27- 8- 4E	N. St. Louis	New	Amerada	Peters	4-26-41	Hunton	3,863	4,346	3,935	A. Fl. 534	19 oil
Pottawatomie	32- 8- 5E	S. Maud	New	Kerlyn	Cherry	2-18-41	Dolomite	4,290	4,330	4,325	A.P. 164 oil; 72 water	2 oil
Pottawatomie	32- 8- 5E	S. Maud	N.Fm.	Atlantic	Merkle	5-12-41	"Wilcox"	4,322	4,367		P. 318 oil	7 oil; 2 dry
Pottawatomie	16- 7- 5E	E. St. Louis	New	Eagle	Schoolland "B"	7- 7-41	"Wilcox"	4,111	4,119		P. 466	2 oil; 2 dry
Pottawatomie	16- 7- 5E	E. St. Louis	N.Fm.	Eagle	Schoolland "C"	8-25-41	Calvin	2,792	2,818		P. 140	1 oil; 1 dry
Pottawatomie	16- 7- 5E	E. St. Louis	N.Fm.	Eagle	Schoolland "C"	9-15-41	Dolomite	4,065	4,125	4,117	A.P. 155 oil; 140 water	4 oil
Pottawatomie	16- 5- 3E	Byars	Ext.	Patsy	Caldwell	12- 8-41	Viola	3,530	3,679		Fl. 210 in 3 hours	1 oil; 1 dry
Hughes	13- 9-10E	E. Wetumka	N.Fm.	Potco	Morrison	8-12-41	Hunton	3,738	3,761		A. Fl. 232 oil; 71 water; 6 hours	5 oil; 1 drlg.
Hughes	16- 5-11E	Hull Top	N.Fm.	Magnolia	McKoy	3- 4-41	Cromwell	5,373	7,025	5,424	10⅜ M. gas	1 gas; 1 dry
Pontotoc	9- 3- 5E		New	Blackwell	Riddle	9-21-41	Cromwell	858	1,543	1,025	2 M. gas	1 gas
Coal	27- 2- 9E	Centrahoma	N.Fm.	Ramsey	Harriman	5-27-41	McAlester	1,246	1,340		10½ M. gas	2 gas
Cleveland	13- 7- 2W	Noble	N.Fm.	Delaney	Montgomery	6-16-41	2d "Wilcox"	7,640	7,650		Fl. 215	1 oil
Caddo	2- 5-12W	Apache	New	Texas	Smith	9-29-41	2d "Wilcox"	3,394	3,433		Fl. 1,434	7 oil; 1 abd. 11 drlg.
Stephens	35-1S- 5W	Velma	N.Fm.	Skelly	Roberson	6-21-41	Bromide	7,140	7,797	7,580	Fl. 204	1 oil; 1 drlg.
Stephens	8-3S- 5W	W. Loco	New	Brown	Lowery	6- 3-41	Pa. sand	1,113	1,856	1,190	P. 35	3 oil; 1 gas; 6 dry
Love	34-6S -2E		New	Batson	Walden	9-15-41	Viola	2,180	2,703		A.P. 20	1 oil
Marshall	33-5S- 7E	Cumberland	N.Fm.	Pure	Thompson	11-16-41	McLish	5,709	5,756		576	2 oil

Fl.—Flowed. P.—Pumped. A.—Acidized. Swb.—Swabbed. New—New pool. N.Fm.—New producing formation. Ext.—Extension.
Initial production shown in barrels, for oil. M = 1,000,000 cubic feet, for gas production.

wells had caused as many as 10 wells to be drilled by the end of the year. The Guthrie, Apache, Tecumseh Lake, and West Hotulke pools are the only new pools which have caused much drilling. The Greater Seminole area continues to dominate the picture in new work. Forty-three of the 81 successful operations and 24 of the 41 new pools were in Seminole, Pottawatomie, and Okfuskee counties.

The Pennsylvanian and Ordovician deposits are of equal importance from the standpoint of new discoveries. Table V lists 31 of the successful operations to be producing from Pennsylvanian sands, and 31 from Ordovician formations.

TABLE V

STRATIGRAPHIC DISTRIBUTION OF NEW DISCOVERIES

	*Pennsylvanian**	*Mississippian*†	*Silurian-Devonian*	*Ordovician*
New pools	14	3	9	15
New formations	12	1	4	10
Extensions	5		2	6
	31	4	15	31

* Including Cromwell.
† Including Misener.

Following is a brief résumé of some of the more important pools.

APACHE

Apache is the most important new pool in Oklahoma, both from the standpoint of potential production and new territory opened to exploration. It is in T. 5 N., R. 12 W., Caddo County, on the northeast flank of the Wichita Mountains. The first well in this pool, The Texas Company's Smith No. 1, center of the NE. $\frac{1}{4}$, NW. $\frac{1}{4}$ of Sec. 2, T. 5 N., R. 12 W., was spudded on September 18, 1938. The Hunton limestone was topped at 1,661 feet, Sylvan shale at 2,258 feet; and at 2,424 feet, in dolomitic Sylvan shale, gas was encountered and blew out of control. The Viola limestone was topped at 2,543 feet, and 7-inch casing was set at 2,556 feet to control the gas. On October 15, 1938, the well was shut down at 2,556 feet and tools moved out to await an improved crude-oil market. On August 5, 1940, cement plugs were drilled out, and deepening commenced. The Viola limestone was cored repeatedly, and nearly every core was stained and showed gas. The hole was found to be 23° off vertical between 3,299 and 3,417 feet, and was plugged back from 3,423 feet, total depth, and whipstocked. In the new hole, Simpson dense limestone was encountered at 3,713 feet, and at 4,278 feet the drill re-encountered Viola. Drilling was stopped at 4,396 feet in Viola limestone and the hole plugged to save the gas.

The Texas Company's Smith No. 2 center of the SE. ¼, NW. ¼ of Sec. 2, T. 5 N., R. 12 W., was credited as the actual discovery well of the pool. Completed in September, 1941, at 3,433 feet, total depth in Simpson (Bromide?) sand, it flowed 1,466 barrels of oil in 24 hours, with an estimated 3 million cubic feet of gas. The oil is 39.2° gravity, corrected. Gas in considerable quantity is encountered in upper formations, notably the Sylvan dolomite and the Viola limestone. Control of this gas was a serious problem in the first few wells, but it should play an important part in future repressuring or gas re-cycling when the Simpson gas declines. Dips as steep as 67° have been measured in cores, and duplicated sections have been drilled in one well. At the end of 1941 there were seven producing oil wells, one abandoned gas well (Smith No. 1), eleven drilling wells, and three locations. The Texas Company owns most of the leases in the pool, as well as the greater part of the area in a northwest-southeast trend extending several miles from the pool. The Arbuckle limestone of Cambro-Ordovician age is exposed in the southwest part of T. 5 N., R. 12 W., the nearest exposure in Section 19 being about 5 miles from the pool. Pre-Cambrian granite is exposed in Sec. 1, T. 4 N., R. 13 W., about 8 miles away. Limited exposures of Simpson sands occur on the southwest flanks of the Viola limestone knobs in T. 6 N., Rs. 15 and 16 W., about 25 miles west of the pool.

The discovery of the Apache pool resulted from an extensive seismograph survey of the area.

The trap is an elongate asymetrical fold, probably overturned.

GUTHRIE

In March, 1941, E. W. Hamilton *et al.* completed the Donoghue No. 1, NW. ¼, SE. ¼ of Sec. 7, T. 17 N., R. 1 W., northeast of Guthrie in Logan County. The log showed the formations structurally high, and the second "Wilcox" sand was found at 5,425 feet. The well stopped at 5,445 feet and produced 2,444 barrels oil and 1,153,000 cubic feet of gas daily. Hamilton's interest was bought out by the Continental Oil Company. The Sunray Oil Company, which held an original 50 per cent interest in the well, took over operation and development of the pool. Subsequent drilling revealed oil in the Bartlesville (Pennsylvanian) sand, and at the close of the year there were twenty-five wells producing from the second "Wilcox" sand, and five from the Bartlesville sand.

The presence of a subsurface nose, or terrace, here had been known for a long time, but it was believed there was insufficient closure for production.

NAVINA

One of the most persistently tested areas in central western Oklahoma was brought into production by the completion of the Continental Oil Company's Leniger No. 1, SW. ¼, SE. ¼, SW. ¼ of Sec. 17, T. 15 N., R. 3 W., in July, 1941. No less than a dozen wells have been drilled in this area in the last few years, all seeking to localize the "high" where it was believed oil would be found. The first encouragement for the area was the Sinclair Prairie Oil Company's Koetch No. 1. SW. ¼, SW. ¼, SW. ¼ of Sec. 23, T. 15 N., R. 3 W., completed in March, 1936, at 6,333 feet in second "Wilcox" sand. This well produced as high as 85 barrels of oil per day, but declined rapidly. Four other wells have been drilled within ½ mile of this well, the latest completed, May, 1941. All have thoroughly tested the section without success.

The Leniger test reached the first "Wilcox" sand at 6,219 feet and cored saturated sand. The second "Wilcox" was topped at 6,392 feet and was drilled without showings of oil or gas to 6,422 feet, total depth. It was plugged back to 6,250 feet and completed in the first "Wilcox," producing 80 barrels of oil and 10 barrels of water, with 6 million cubic feet of gas.

This well has been shut in since completion because of lack of outlet for either oil or gas.

TOWNSHIP 9 NORTH, RANGE 4 EAST

The probability that all the major oil fields in the Seminole area have been discovered has long been recognized. Yet operators, both independent and major, are loath to forsake an area that has yielded so much oil. This has led to a campaign of reworking the area in considerably more detail in an effort to locate smaller structures which were overlooked or ignored in earlier surveys. Of all the methods used, the seismograph has been most successful. A factual record of what was done in T. 9 N., R. 4 E., during 1941 lends encouragement for further prospecting on the vast Seminole uplift.

EAST TECUMSEH POOL

The East Tecumseh pool was discovered by the Atlantic Refining Company and J. E. Crosbie, Inc., on April 21, 1941, when they completed their Schoolland No. 1, center of the E. ½, NE. ¼, SW. ¼ of Sec. 16, T. 9 N., R. 4 E., in the Viola limestone, producing 651 barrels of 35° gravity oil in 24 hours, after acidization. The Viola was reached at 4,582 feet, the first "Wilcox" at 4,714 feet, and drilling stopped at 4,722 feet. As a drill-stem test of the" Wilcox" yielded only salt water,

the 7-inch casing was set at 4,713 feet and the sand cemented off. The casing was then perforated through the Simpson dolomite, after which it was acidized without beneficial results. It was plugged back to 4,652 feet and perforated and acidized through the Viola limestone, where it produced 651 barrels of oil.

On September 8, 1941, the well No. 3, NW. ¼, SE. ¼, SW. ¼ of Sec. 16, on the same lease, produced 350 barrels of oil from the Viola, after acidization. This well drilled directly to the second "Wilcox" sand, 4,801–4,817 feet, total depth, and 7-inch pipe was cemented at 4,800 feet. When plugs were drilled, salt water was found. The casing was then perforated through the first "Wilcox," but this also yielded salt water, with only a showing of oil. It was then plugged back, perforated, and acidized in the Viola. Thus, with two first "Wilcox" sand dry holes and one second "Wilcox" sand dry hole, it looked like a one-formation pool. On December 1, with seven Viola wells producing, a third deep test was completed. This was the Schoolland No. 6, NW. ¼, NE. ¼, SE. ¼ of Sec. 16, which drilled directly to the second "Wilcox" sand, which was dry. The Viola limestone was perforated and acidized, and the Hunton limestone perforated, without avail, and the well was completed as the first dry hole of the pool.

Two weeks later, the Atlantic Refining Company completed Lee No. 3, NW. ¼, SW. ¼, SE. ¼ of Sec. 16, producing 198 barrels of 38° gravity oil and 24 barrels of water in 24 hours from the second "Wilcox" sand, 4,838–4,850 feet, total depth.

WEST HOTULKE POOL

On July 14, 1941, Sharp *et al.* completed Billington No. 1, NW. ¼, SE. ¼, SE. ¼ of Sec. 21, T. 9 N., R. 4 E., just one mile south of the discovery well of the East Tecumseh pool. The Billington well went to the first "Wilcox" sand, 4,636–4,640 feet, total depth, where it swabbed salt water. It was plugged back, the casing perforated through the Viola, topped at 4,490 feet and the hole was acidized. It pumped 500 barrels of 37° gravity oil and 160 barrels water in 36 hours.

On September 1, the Atlantic Refining Company discovered second "Wilcox" oil in Higbee No. 1., SE. ¼, NW. ¼, SW. ¼ of Sec. 22. The producing sand was topped at 4,629 feet and drilled to 4,647 feet, total depth, where the well pumped 629 barrels of 38° gravity oil. At about the same time, Smith and Sunray extended the pool ¾ mile east, and discovered first "Wilcox" oil in Billington No. 1, SE. ¼, SE. ¼, SE. ¼ of Sec. 22. Here the sand was topped at 4,429 feet and drilled to 4,445 feet, total depth, where the well produced 256 barrels

of 37° gravity oil and 200 barrels of water in 24 hours. A month later an effort was made to plug off the water and still produce from the sand. As this was unsuccessful the well was deepened to the second "Wilcox" sand, topped at 4,519 feet. This, too, was unsuccessful; the well was plugged back, the casing perforated, and the well acidized in the Hunton where it produced 75 barrels of oil and 80 barrels of water in 24 hours.

HOTULKE POOL

In addition to the activity previously outlined, there were twenty-four producing oil wells completed in Secs. 24, 25, and 26, T. 9 N., R. 4 E. Most of these wells produce from the Hunton limestone, topped at approximately 4,100–4,150 feet. This development was the outgrowth of discoveries made by the Alma Oil Company in the NW. ¼, SE. ¼, NW. ¼ of Sec. 24, T. 9 N., R. 4 E., in June, 1940, and by the Mudge Oil Company in the NW. ¼, NW. ¼, NW. ¼ of Sec. 25, T. 9 N., R. 4 E., in December, 1940. Both wells produced from the Hunton limestone.

VELMA

In 1917, the Velma oil pool was discovered and subsequently developed in Permian and Pennsylvanian sands at relatively shallow depths. In November, 1941, the Skelly Oil Company completed Robberson No. 4 in the center of the NE. ¼, NE. ¼ of Sec. 35, T. 1 S., R. 5 W., as a Simpson (Bromide) producer. The Bromide sand was drilled from 7,015 to 7,200 feet, with showings of oil and gas throughout the sand. Drill-stem tests verified these showings as of commercial value, but the well was drilled to 7,797 feet to test the McLish sand topped at 7,695 feet. This was dry and the well was then plugged back to 7,580 feet where it was completed and flowed 204 barrels of oil per day from the Bromide sand. Because of the depth and the small potential, only one other well is being drilled to this sand. The finding of Simpson oil in this pool has revived interest in the many old fields of southern Oklahoma which have produced for years from upper sands without adequate test of the deeper formations.

Present knowledge of the Simpson structure at Velma is limited to the core records, which reveal an increase in dip with depth. Cores taken in the upper part of the Bromide sand showed dips of 40°. Subsequent cores showed steeper dips, the steepest, of 59°, being in the deepest core, 7,730–7,748 feet in the McLish sand.

IMPORTANT DRY HOLES

There were 641 dry holes drilled in 1941, not counting input or disposal wells. About 250 of these were wildcat wells. Each well has

added to the knowledge of the stratigraphy and structure of the state. A brief résumé of a few of the more important wells follows.

The Gulf Oil Corporation's Hess No. 1, Sec. 33, T. 23 N., R. 13 W., Major County, total depth 8,367 feet, in the second "Wilcox" sand, was a seismograph play on the northeast flank of the Anadarko basin.

Harry Miller *et al.*, Katschor No. 1, Sec. 7, T. 16 N., R. 2 W., Logan County, total depth 5,928 feet, in second "Wilcox" sand, was logged high from the first reliable marker, and was drilled from Pennsylvanian Cherokee shale directly into Hunton limestone. On the Viola it was nearly 200 feet higher than a dry hole ½ mile south. However, on drill-stem test it produced only a showing of oil and salt water. It was drilled in the Guthrie townsite.

Texas, Schoolland No. 1B, Sec. 13, T. 4 N., R. 11 W., Comanche County, total depth 5,223 feet, in Mississippian Caney shale, was drilled into Simpson limestone at 2,736 feet, then drilled a normal section upside down, going from Simpson back into Viola, Sylvan, Hunton, Woodford, Sycamore, and ended in Mississippian Caney shale. It is located on the Apache trend, parallel with the Wichita Mountains.

Texas, Gamble No. 1, Sec. 5, T. 3 N., R. 10 W., Comanche County, total depth, 6,276 feet, in Mississippian Caney shale, after drilling 1,624 feet of Woodford shale, went back into Sycamore, then into Mississippian Caney. Like the Schoolland No. 1B, this well is on the Apache trend which parallels the Wichita Mountains.

Texas, Schoolland No. 1, Sec. 13, T. 3 N., R. 10 W., Comanche County, total depth, 7,170 feet, in Pennsylvanian (Cisco?) limestone, located on the same trend as the Gamble and Schoolland No. 1B, drilled a long section of arkosic shales and sands of probable Pennsylvanian age, and stopped in Pennsylvanian limestone.

Ohio, Feaster No. 1, Sec. 13, T. 3 N., R. 1 E., Garvin County, total depth 4,401 feet, in Arbuckle limestone, is the latest and highest well drilled in the Pauls Valley play.

Sinclair Prairie, Ingram No. 1, Sec. 21, T. 4 S., R. 3 W., Carter County, total depth 2,765 feet, in Arbuckle limestone, is a deep test on the downthrown side of the main Healdton structure.

Sinclair Prairie, Irwin No. 1, Sec. 8, T. 6 S., R. 12 E., Bryan County, total depth, 2,033 feet, in Arbuckle limestone, spudded on the Cretaceous overlap and is about equi-distant from the Arbuckle Mountains on the northwest, and the Ouachita Mountains on the northeast. It drilled an Arbuckle Mountain facies.

Magnolia, Wilson No. 1, Sec. 12, T. 7 S., R. 2 E., Love County, total depth 4,935 feet, in Sycamore limestone, was drilled as a deep test on the Overbrook anticline, but was abandoned after drilling from the Woodford shale back into the Sycamore limestone.

IMPORTANT WELLS DRILLING AT CLOSE OF 1941

A few wildcat wells drilling as the year closed are of sufficient interest to merit some mention here.

Gulf, Cox No. 1, Sec. 35, T. 2 N., R. 8 E.C.M., Cimarron County, is the first well drilled as a result of the recent Panhandle play, and the location was made after surveys by magnetometer, gravimeter, and seismograph. The well was drilling at 4,576 feet as the year closed and has since been abandoned. It is the first well in the Oklahoma Panhandle to test the Simpson sands and Arbuckle limestone.

Continental, Boling No. 1, Sec. 18, T. 14 N., R. 3 W., Oklahoma County, drilling at 6,150 feet and since abandoned at 6,760 feet, after testing the second "Wilcox" sand, was another attempt to extend production on the granite ridge between the Edmond and Crescent pools.

Denver, Sah Cam No. 1, Sec. 33, T. 10 N., R. 10 W., Caddo County, drilling at 12,600 feet, was originally completed at 10,084 feet in 1936, and temporarily abandoned after it failed to produce from the sand topped at 9,985 feet, which produced in the original Adahnoe well drilled to 11,230 feet in Sec. 34, T. 10 N., R. 10 W. The Sah Cam well was cleaned out in September, 1941, and rigged up to deepen. It was drilled to 13,842 feet, apparently still in Pennsylvanian, where it lost circulation and the drill pipe stuck. It is fishing now.

Amerada, Sprague No. 1, Sec. 11, T. 8 N., R. 12 W., Caddo County, drilling at 9,750 feet, and since abandoned at 10,231 feet, after finding repeated oil stains in thin sand lenses of Pennsylvanian age, was located following a seismograph survey of the area.

Marshall *et al.*, Burris No. 1, Sec. 4, T. 6 S., R. 6 E., Marshall County, is a proposed location to test a reported trend parallel with the Cumberland pool.

CONCLUSION

The status of the petroleum industry in Oklahoma changed little during 1941, but what change there was indicated improved conditions. The rate of discovery of new pools was maintained and the annual production and the estimated reserves were both increased. Under normal conditions it would seem that Oklahoma's position should continue to improve during 1942. However, the restrictions

placed on the oil industry by the 40-acre spacing rule probably will curtail production. Wildcatting and the discovery of new pools may continue unabated, but development following discovery will be slow. Many of the untested structures in Oklahoma are small and the difference in spacing between the old and the new drilling patterns may mean the difference between success and failure in offset wells in such cases. Under such conditions it seems inevitable that the state's production will decline in 1942, unless it can be abnormally bolstered by deepening or by plugging back to other formations in old wells.

The need for the petroleum geologist is more acute than ever. Present-day warfare and present-day business could not be conducted without oil. Oil in ever increasing quantities must be found; if not in Oklahoma, then the search must turn elsewhere. The petroleum geologist is the only one capable of conducting and directing this search. Present methods must be improved, and new methods and new technique must be developed and successfully applied in our search for future reserves.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1073-1085, 1 FIG.

DEVELOPMENTS IN NORTH MID-CONTINENT IN 1941[1]

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ABSTRACT

The discovery of commercial production in a sandstone in the lower part of the Pennsylvanian system in Kearny County, Kansas, was the outstanding development in the North Mid-Continent region in 1941. The true importance of this discovery remains somewhat problematic at present because of the lack of development in its vicinity. Further exploration in this geologic province will probably be reduced by war conditions.

Otherwise, Kansas experienced a year of routine development in and around proved areas. There was a sharp increase in wildcat activity, with a consequent increase in the percentage of dry holes from 20.3 per cent to 26.9 per cent. Productivity developed by oil-well completions fell from about 2,200,000 barrels to 1,700,000 barrels, and the average potential per well fell from 1,561 barrels to 1,379 barrels. An important group of pools was found along the Peace Creek trend in southwest Reno County, which will probably result in a large share of the drilling activity for 1942. These pools are northeast of the Zenith pool and have similar characteristics. Several small and relatively unimportant pools were found on the Central Kansas uplift, but with the exception of the Ray pool in Phillips County, attempts to develop important production in northwestern Kansas were relatively unsuccessful. Development of the McLouth pool in the Forest City basin continued.

In Nebraska, the Falls City pool of Richardson County was enlivened by the discovery of a deeper "pay" in the Hunton dolomite. The Barada pool was discovered about the middle of the year, and gives promise of developing into a small pool similar to Falls City. Wildcatting elsewhere in both east and west Nebraska was unsuccessful although much stratigraphic information was secured.

Six deep tests were completed in the Forest City basin part of Missouri, and six dry holes were drilled in Iowa with little promise for commercial production. No wells were completed in South Dakota during the year although a great amount of exploratory work was done. Several stratigraphic tests were drilled. Low crude-oil prices discouraged extensive wildcatting throughout the North Mid-Continent area.

INTRODUCTION

The most important feature of development in the North Mid-Continent in 1941 was the discovery of the Patterson pool in Kearny County, Kansas. Production was found 25 miles southwest of the nearest pool, in a sand in the lower part of the Pennsylvanian system. The size of the pool at present is undetermined, but the significance of this discovery in a new producing zone in western Kansas can not be over-emphasized. Although wildcatting increased over the previous year there were no other important discoveries. Kansas developments consisted principally in the development and extension of known fields. In southeastern Nebraska, a new pool was found at Barada, and a deeper "pay" at Falls City. Production in the state passed the 2 million-barrel mark. A few encouraging showings in Pennsylvanian rocks were found in western Nebraska, but no commercial production.

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, March, 1942.

[2] Darby Petroleum Corporation.

Iowa and Missouri completed a few more deep tests, but there is little enthusiasm left in the deep play there. Exploratory work continued in the Dakotas, but drilling consisted mainly of stratigraphic tests.

KANSAS

DRILLING ACTIVITY

Drilling activity in Kansas for the last 3 years is summarized in Table I.

TABLE I

	1941	*Percentage*	*1940*	*Percentage*	*1939*	*Percentage*
Oil wells	1,253	68.9	1,421	76.4	983	70.8
Gas wells	75	4.2	61	3.3	62	4.5
Dry holes	490	26.9	377	20.3	343	24.7
	1,818		1,859		1,388	

The figures for 1941 do not include recompleted wells. In this classification there were 126 oil wells with a potential of 135,574 barrels, 38 gas wells with a capacity of 570,319,000 cubic feet, and 29 dry holes.

The increase in the percentage of dry holes from 20.3 per cent to 26.9 per cent reflects the increase in wildcat activity.

TABLE II

Year	*Oil Wells*	*Barrels Potential*	*Barrels Average Potential*	*Gas Wells*	*Capacity in 1,000 Cubic Feet*	*Average Capacity in 1,000 Cubic Feet*
1939	983	1,548,772	1,577	62	1,280,984,000	20,661,000
1940	1,421	2,218,720	1,561	61	1,292,201,000	21,183,000
1941	1,253	1,727,593	1,379	75	797,011,000	10,626,000

The decline in the production of new wells in 1941 compared with 1940 can be attributed to the fact that most of the highly productive fields have been drilled up, and very few large areas of prolific production have been found in the past 3 years to take their place. The completion of many moderate-size wells in small fields resulted in the addition of $1\frac{3}{4}$ million barrels of productivity. However, the production of the older prorated fields fell so much that the total potential production in the state increased only about one million barrels, from 7,068,000 barrels at the close of 1940 to 8,067,794 barrels at the end of 1941.

LEASING ACTIVITY

Early in the year a heavy leasing activity began in northwestern Kansas and adjacent parts of southwestern Nebraska. This leasing

covered principally Decatur, Rawlins, Sheridan, Thomas, and Cheyenne counties, Kansas, and Dawson, Lincoln, Gosper, Frontier, Hayes, Furnas, Red Willow, and Hitchcock counties, Nebraska. Following the discovery of the Patterson pool in August, much land was leased in the southwestern part of Kansas. Late in the year several blocks and many checkerboard leases were taken in Pawnee County, and to a lesser extent in Edwards and Rush counties. The discovery of four fields on the Peace Creek trend in Reno encouraged leasing in that county toward the end of the year. In December, Barber and Comanche counties experienced heavy leasing activity after the discovery of the Sun City and Skinner pools. Leasing in other parts of western Kansas continued fairly active throughout the year, although the Forest City basin was quiet. As a matter of policy, a few companies reduced their holdings throughout Kansas, but most of them added considerably to their non-producing acreage account.

PRODUCTION

Kansas produced 83,229,159 barrels of crude oil in 1941 compared with 64,824,721 barrels in 1940, an increase of 28 per cent. The increased production was due to a greater demand and a larger pipeline outlet. Kansas experienced little trouble in increasing its output of oil as additional pipeline outlets were available.

The average daily allowable in barrels per prorated well during the past 2 years fluctuated as follows.

	1940	*1941*		*1940*	*1941*
January	21.2	22.4	July	19.0	26.8
February	22.3	22.1	August	19.9	28.1
March	22.4	22.8	September	22.7	27.7
April	18.7	24.0	October	21.4	28.7
May	19.9	24.9	November	21.9	28.2
June	19.1	26.5	December	21.8	28.6

This allowable figure was reduced to 27.7 barrels per day per well in January and 26.6 barrels in February, 1942, due to the reduction of Kansas allowable by the Petroleum Coordinator.

The pipeline capacity of Kansas at the end of 1941 was about 259,000 barrels per day, but extensions and the looping of lines proposed or under construction will increase this figure to about 310,000 barrels before May 1.

WILDCATTING

Wildcat drilling increased about 63 per cent over 1940. Some of the increased drilling was in the Forest City basin where results were not encouraging, and no new pools were found. Most of the remainder of the wildcats were on the Central Kansas uplift, and many of them were attempts to extend known producing areas. Many of the dis-

coveries classified as new pools now will eventually be joined with old fields. Toward the end of the year there was increased interest in the southwestern flank of the Central Kansas uplift, and future drilling of this area chiefly in Pawnee County is expected in 1942. A play is also developing in Barber County.

Various figures have been published in trade journals about the amount of new reserves discovered in Kansas in 1941 by wildcat drilling and extensions of old fields. The writer does not hazard an estimate of these reserves except to say that Kansas failed to discover sufficient oil during 1941 to match the 83 million barrels produced. Present low prices for crude oil do not warrant wildcatting on an extensive scale sufficient to replace Kansas withdrawals from reserves.

TABLE III

	Producing	*Dry*	*Total*
Non-geological			
Chance	3	59	62
Expiring leases	3	11	14
Geological			
Subsurface	15	36	51
Core drill	4	27	31
Seismograph	8	23	31
Surface	3	16	19
Surface and subsurface	0	1	1
Subsurface and seismograph	0	1	1
Core drill and seismograph	1	9	10
Showing in old well	0	14	14
Core drill and subsurface	0	1	1
Subsurface and radioactivity	0	1	1
Magnetometer	0	1	1
Totals	37	200	237

One of the interesting features brought out by Table III is the success of subsurface methods of discovering new production. This has been especially true in Kansas during the past 2 years, and is indicative of a trend which probably will continue until more direct methods of locating oil can be found. More prospecting with the drill for stratigraphic traps, and retests of old blocks will be necessary. New interpretations of all kinds of old exploratory work will be used to find new pools. An example of this geological approach is found in the four new pools (which eventually may be proved as only one field) along the Peace Creek trend northeast of Zenith in Reno County. These four pools were found after five dry holes, three of which were located on seismograph work, had been drilled. In three cases the discovery well was within a mile of a dry hole.

Table IV shows a comparison of wildcatting in 1938, 1939, 1940, and 1941.

TABLE IV

Year	*Oil and Gas Wells*	*Total Feet*	*Dry Holes*	*Total Feet*	*Total Wells*	*Total Feet*
1938	43	148,050	129	478,389	172	626,439
1939	21	67,259	74	258,031	95	325,290
1940	23	75,142	122	408,887	145	484,020
1941	37	140,284	200	688,189	237	828,473

The average discovery well in 1941 had a depth of 3,791 feet compared with 3,267 feet in 1940. The average dry hole in 1941 was drilled 3,440 feet compared with 3,351 feet in 1940. The deepest wildcat was drilled to 5,690 feet; only four reached below 5,000 feet and only forty-two exceeded 4,000 feet.

NEW POOLS

Table V lists the new pools discovered in western Kansas in 1941 as named by the nomenclature committee of the Kansas Geological Society. That this relatively large number of individual discoveries represents a very small amount of new reserves is shown by the fact that at the beginning of 1942 only 11 of the 37 new pools had more than one producing well. One of the pools had already been abandoned. It is questionable at present whether some of the discoveries are of commercial importance.

The Stanolind Oil and Gas Company's Patterson No. 1 in Sec. 23, T. 22 S., R. 38 W., was completed with an initial production of 3,000 barrels per day in a sand in the lower part of the Cherokee of Pennsylvanian age at a depth of 4,740–4,752 feet. This sand was found about 75 feet above the top of the glauconitic limestones interpreted as representing beds of Morrow age. This "pay," which has been termed the Patterson sand, previously has not produced commercially in western Kansas. At the end of the year one offset producer and one offset dry hole had been completed in the pool. This production is 25 miles southwest of Mississippian limestone production in the Shallow Water pool, T. 20 S., R. 33 W., Scott County. Not only is this discovery important in extending the producing area of Kansas westward, but it also opens the possibilities of extensive areas in western Kansas and eastern Colorado to commercial production. A few wells drilled in a broad area have indicated a thick Cherokee section containing sandy zones somewhat similar to the "pay" in the Patterson pool. Additional prospecting in this part of the state no doubt will be handicapped by war-time conditions.

The most prolific new pool of the year was Peace Creek. This area lies in T. 23 S., R. 10 W., Reno County, northeast of the active Zenith

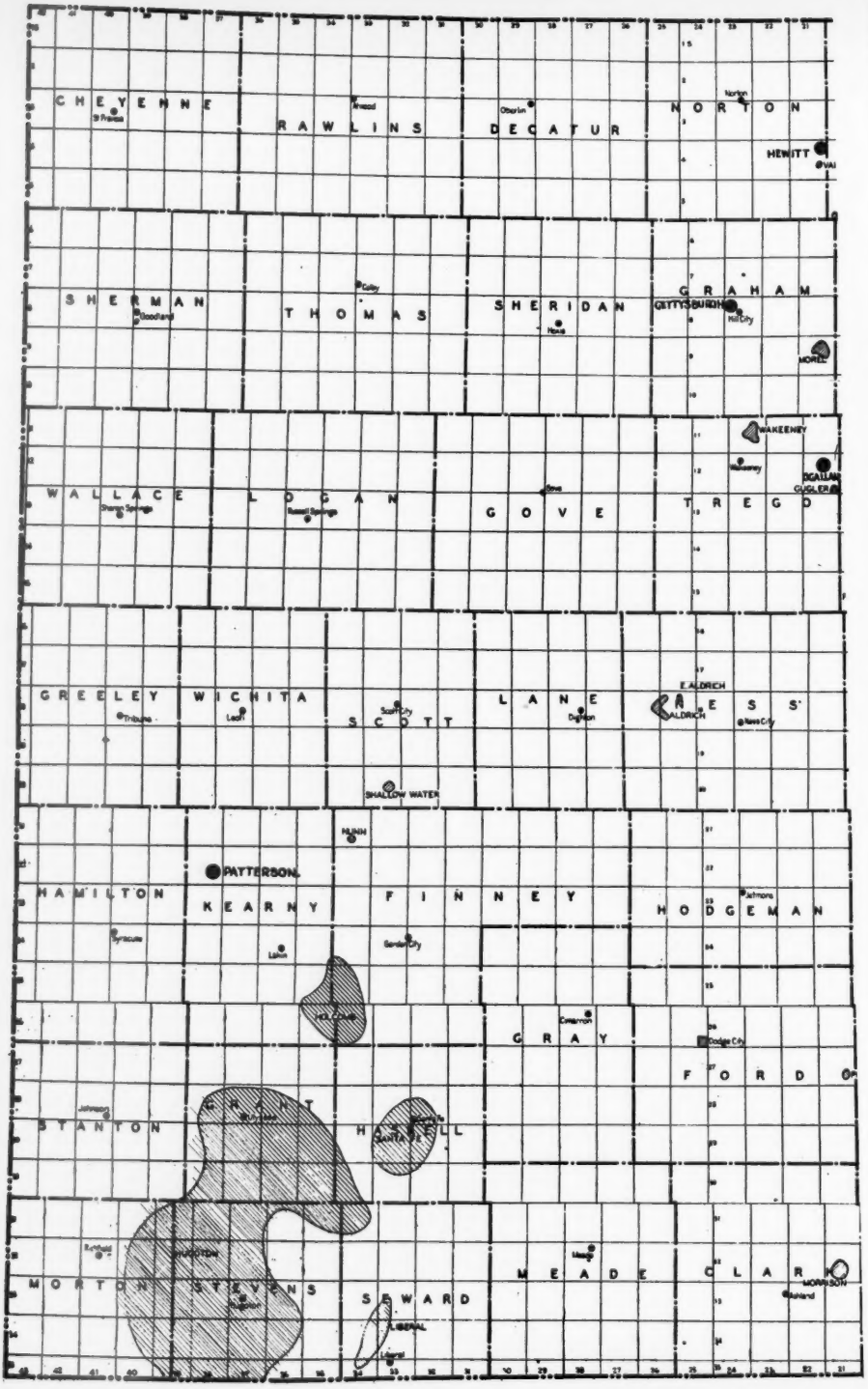
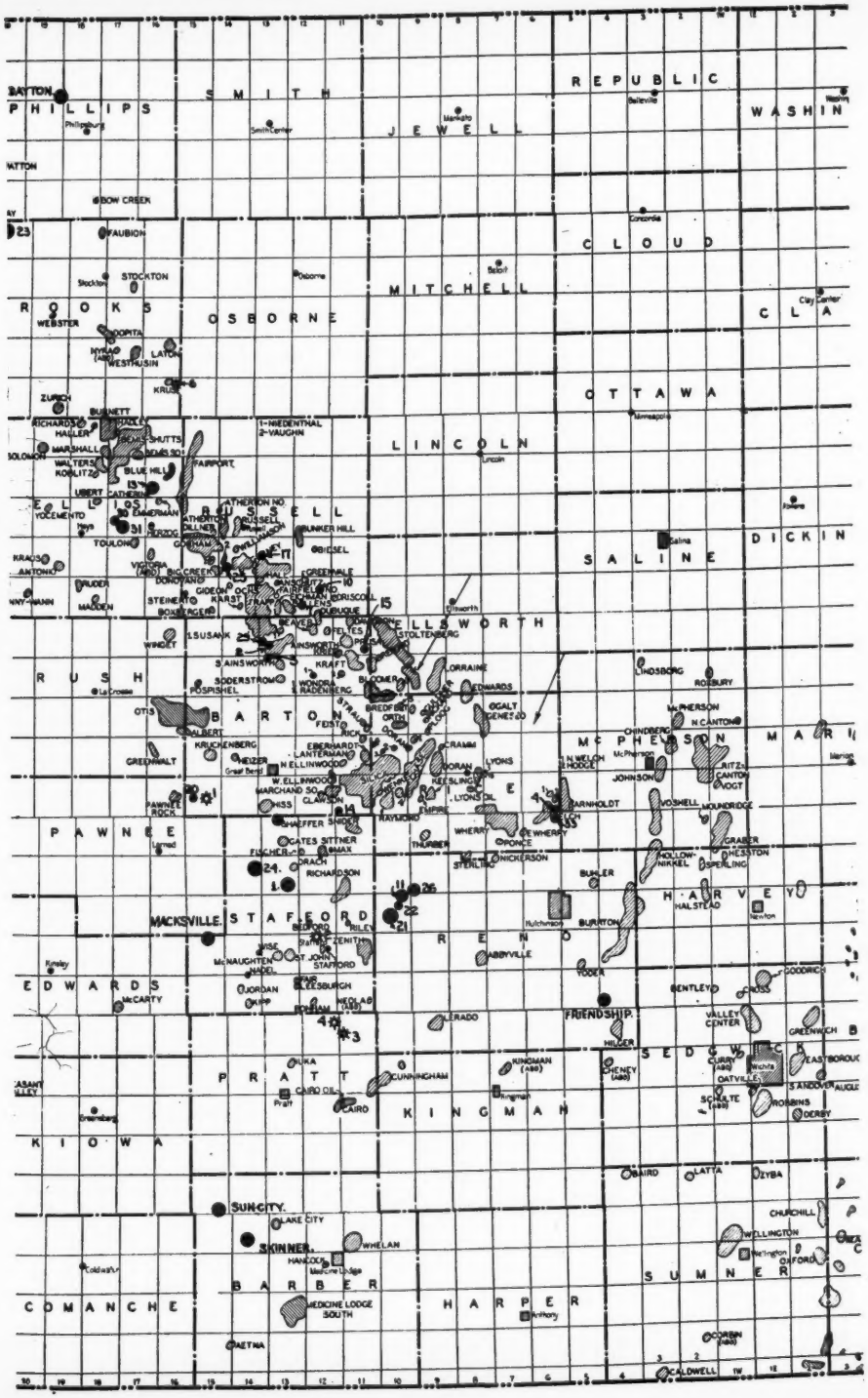


FIG. 1.—Kansas oil-pool map, showing discoveries



of 1941, with numerical reference to Table V.

TABLE V

LIST OF NEW AREAS OF PRODUCTION DISCOVERED IN WESTERN KANSAS DURING 1941

OIL FIELDS

Map No.	Field	County	Section-Twn., North-Range, West	Total Depth in Feet	Discovery Month-Day	Producing Formation	Method of Exploration	Barrels Potential
1.	Ahnert	Stafford	26-22-13	3,769	6-17	Arbuckle	Seismograph	1,440
2.	Ainsworth, NW.*	Barton	28-16-13	3,403	4-20	Arbuckle	Core drill	596
3.	Ainsworth, West*	Barton	5-17-13	3,361	8- 9	Arbuckle	Subsurface	296
4.	Bornholdt, West*	Rice	36-20- 6	3,415	11-20	Mississippian	Subsurface	45
5.	Dayton	Phillips	36- 2-19	3,861	6-20	Lans.-Kan. City	Core drill and seismograph	328
6.	Erway	Rooks	2-10-16	3,495	8- 1	Lans.-Kan. City	Subsurface	203
7.	Forest Hill	Russell	29-15-12	3,323	7-30	Arbuckle	Subsurface	1,099
8.	Friendship	Reno	30-25- 4	3,986	11-16	Viola	Subsurface	495
9.	Gettysburgh	Graham	7- 8-23	4,018	9-28	Lans.-Kan. City	Core drill	252
10.	Gustason	Russell	14-15-12	3,246	7-28	Arbuckle	Subsurface	163
11.	Hendrickson*	Reno	2-23-10	3,744	12- 4	Viola	Subsurface	217
12.	Hewitt	Norton	11- 4-21	3,750	7- 7	Lans.-Kan. City	Core drill	272
13.	High Spot	Ellis	28-12-16	3,626	2- 5	Lans.-Kan. City	Chance	647
14.	Kowalsky	Barton	32-20-11	3,408	12- 7	Arbuckle	Subsurface	165
15.	Kraft-Prusa, East	Barton	36-16-11	3,370	12- 7	Arbuckle	Seismograph	544
16.	Macksville	Stafford	3-24-15	4,155	3-31	Lans.-Kan. City	Seismograph	410
17.	Mohl	Russell	18-14-13	3,258	10- 4	"Gorham sand"	Chance	153
18.	Ogallah	Trego	10-12-21	4,005	11-15	Arbuckle	Seismograph	30
19.	Patterson	Kearny	23-22-38	5,690	8- 8	Penn. sand	Seismograph	3,000
20.	Pawnee Rock, East*	Barton	17-20-15	3,877	10-18	Arbuckle	Expiring leases	583
21.	Peace Creek	Reno	21-23-10	3,789	7-13	Viola	Subsurface	3,000
22.	Peace Creek, NE.*	Reno	11-23-10	3,768	12- 1	Viola	Subsurface	3,000
23.	Ray, Southeast	Rooks	9- 6-20	3,639	12-29	Pre-Cambrian	Core drill	65
24.	Roach	Stafford	12-22-14	3,840	1- 1	Arbuckle	Chance	128
25.	Rusch	Russell	29-14-14	3,223	5-28	Arbuckle	Surface	3,000
26.	Schweizer*	Reno	31-22- 9	3,725	12-26	Viola	Subsurface	774
27.	Shaeffer	Stafford	3-21-13	3,552	3- 4	Lans.-K. C. and Arb.	Seismograph	1,175
28.	Skinner	Barber	21-31-14	4,780	9-21	Viola	Surface	40
29.	Stickney*	Barton	29-16-13	3,386	8- 9	Arbuckle	Expiring leases	50
30.	Sugar Loaf	Ellis	17-13-17	3,653	3-23	Arbuckle	Seismograph	482
31.	Sugar Loaf, SE.	Ellis	28-13-17	3,626	9- 3	Lans.-Kan. City	Seismograph	352
32.	Sun City	Barber	35-30-15	4,726	12- 2	Lans.-Kan. City	Surface	3,000
33.	Welch, East	Rice	1-21- 6	3,364	10- 5	Mississippian	Subsurface	278

GAS FIELDS

1.	Bergtal	Barton	22-20-15	3,762	9-29	Arbuckle	Expiring leases	1,500
2.	Hitz	Stafford	4-24-12	4,032	10-18	Viola	Subsurface	6,399
3.	Stark	Pratt	18-26-11	4,339	4-28	Viola	Subsurface	12,000
4.	Ward	Pratt	11-26-12	4,320	12- 8	Viola	Subsurface	2,729

* Pools which apparently are extensions of old pools but now classified as new pools.

pool. With its apparent extension at Peace Creek Northeast, Hendrickson, and Schweizer, it was the scene of an active lease, royalty, and drilling campaign in the latter part of the year. Eighteen wells had been completed in the Peace Creek pool by the end of the year with a potential of 48,879 barrels. This development has spurred interest in all parts of western Reno County. Considerable drilling is under way at present in the vicinity.

Barber County received considerable stimulus in December by completion of a flowing well in lower Kansas City beds to discover the Sun City pool. It is Pryor and Lockhart *et al.* Massey No. 1 in Sec. 35, T. 30 S., R. 15 W., which established a maximum potential of 3,000 barrels after 27 perforations at 4,342–4,344 feet. The producing section is a stray zone which has been found in very few near-by wells. Another Barber County wildcat was the Deep Rock Oil Corporation's Skinner No. 1 in Sec. 21, T. 31 S., R. 14 W., which pumped 40 barrels of oil and 25 barrels of water as a temporary potential after perforating the Viola limestone "pay" at 4,551–4,595 feet. Early in 1942, good saturation was found in several zones in a wildcat well in Sec. 26, T. 32 S., R. 15 W., Barber County.

The most northerly production in Kansas was found by the Carter Oil Company in its Friebus No. 1 in Sec. 36, T. 2 S., R. 19 W., Phillips County. The producing formation is in the Lansing-Kansas City group at a depth of 3,329–3,344 feet, and 3,255–3,261 feet. To February 1, 1942, four oil wells and one dry hole had been completed in this pool, which at present appears to be important only in that it indicates commercial production may be expected in this part of the state.

One of the disappointing results of wildcatting in Norton, Graham, and Rooks counties was the discovery of heavy black oil in the Arbuckle dolomite in several wildcat wells located on favorable core-drill and geophysical structures. The poor characteristics of the oil do not indicate this part of the Central Kansas uplift as an important reserve of petroleum.

Numerous tests in Stafford and Pratt counties west and south of the Zenith pool,[3] seeking a Viola limestone pinch-out similar to that found at Zenith, were drilled during the year. As a result the Hitz, Stark, and Ward gas fields were found.

Wildcat drilling in eastern Kansas consisted largely in attempts to find extensions to the McLouth field or pools similar to it. No new pools were discovered although much valuable stratigraphic information was gained. Thirty-three wildcat dry holes representing a total of 70,452 feet were drilled in eastern and central Kansas.

[3] W. C. Imbt, "Zenith Pool, Stafford County, Kansas," *Stratigraphic Type Oil Fields* (Amer. Assoc. Petrol. Geol., 1941), pp. 139–65.

MISSOURI

The completion of 6 additional tests in the Forest City basin of Missouri practically brought to a close the play begun in this area in 1938. No production has been found. The most favorable part of the state having production similar to the Falls City pool appears to lie at the extreme northwestern tip in Atchinson and Holt counties. There was a customary amount of shallow drilling for oil and gas in the vicinity of Kansas City. Table VI shows data on wildcat operations in Missouri and Iowa in 1941.

IOWA

The completion of 6 dry wildcats in Iowa in 1941 supplied more pertinent geological information regarding the oil possibilities of the state than any one year's development had previously furnished. The outlook for commercial oil production in Iowa is not encouraging although the extreme southwestern part of the state may be considered to have possibilities of production similar to the Falls City pool.

TABLE VI

MISSOURI WILDCATS, 1941

County	*Section-Twn., North-Range, West*	*Operator*	*Total Depth (Feet)*	*Formation*	*Method*
Buchanan	20-55-35	Ohio Oil	2,344	Arbuckle	Surface
Holt	1-61-38	Brin & Nathan	2,311	Hunton	Magnetometer
Holt	1-61-38	Brin & Nathan	2,424	Hunton	Magnetometer
Holt	27-62-39	Flory & Kilby	915	Pennsylvanian	Chance
Atchison	12-66-39	Indian Ter. Ill.	2,301	Hunton	Core drill
Atchison	22-66-42	Jackson & Rust	3,289	Arbuckle	Core drill
			13,584		

IOWA WILDCATS, 1941

Fremont	23-68-41	Ohio Oil	3,378	Arbuckle	Surface
Fremont	28-70-43	Barnes *et al.*	1,882	Hunton	Surface
Guthrie	11-78-30	Hunt *et al.*	1,825?	Galena?	Chance
Montgomery	5-72-38	Ohio Oil	2,758	Arbuckle	Core drill
Taylor	32-68-33	Stanolind	2,896	Arbuckle	Seismograph
Taylor	18-69-35	Smythe & McLaughlin	1,537	Mississippian	Surface

NEBRASKA

Drilling activity in Nebraska in 1941 increased to 100 completions compared with 61 in 1940 and 7 in 1939. Most of the activity was in the southeastern part of the state in Richardson and Nemaha counties. The total production in the state to date exceeds 2,100,000 barrels, but the large number of scattered wildcats in eastern Nebraska completed thus far have found very few showings of free oil outside of the four known pools. Wildcats completed or in the process of completion in western Nebraska have found some showings of oil in Pennsyl-

vanian rocks, but their chief contribution has been in furnishing additional subsurface information regarding a large area about which relatively very little is known.

WILDCATTING

Table VII lists dry wildcats completed in western and eastern Nebraska during 1941.

TABLE VII

NEBRASKA WILDCATS, 1941

WESTERN

County	*Section-Twn.-Rge.*	*Operator*	*Total Depth (Feet)*	*Formation*	*Method*
Furnas	28- 1-22W	Marshall *et al.*	3,652	Pre-Cambrian	Chance
Furnas	8- 1-23W	Barnsdall Oil	3,492	Pre-Cambrian	Chance
Furnas	14- 3-23W	Helmrich & Payne	3,558	Pre-Cambrian	Chance
Dawson	21-10-22W	Phillips Petroleum	3,371	Pre-Cambrian	Seismograph
Lincoln	26-11-34W	Falcon-Seaboard Oil	4,832	Pre-Cambrian	Chance
Valley	29-18-13W	Bredthauer *et al.*	3,535	Pre-Cambrian	Magnetometer
		Total	22,440		

EASTERN

Richardson	5- 2-13E	Palensky *et al.* 1	1,956	Pre-Cambrian	Surface
Richardson	5- 2-13E	Palensky *et al.* 2	1,598	Viola(?)	Surface
Richardson	15- 2-13E	McNulty & Bass	2,602	Hunton	Surface
Richardson	15- 2-14E	National Petrol.	2,623	Hunton	Surface
Richardson	3- 2-15E	I.T.I.O. (OWDD)	3,185	Viola	Core drill
Richardson	31- 2-15E	Richco Oil	2,855	Hunton	Chance
Richardson	4- 2-16E	Johnson & Mitchell	2,596	Hunton	Chance
Richardson	8- 2-16E	Trans-Continental	2,550	Hunton	Seismograph
Gage	21- 3- 5E	Rider *et al.*	2,858	Pre-Cambrian	Chance(?)
Richardson	35- 3-16E	Harper *et al.*	2,654	Hunton	Chance
Gage	2- 4- 6E	Miller *et al.*	825	Pennsylvanian	Chance
Nemaha	9- 4-14E	Engles *et al.*	2,745	Hunton	Chance
Nemaha	24- 4-14E	Phillips Petroleum	2,931	Hunton	Seismograph
Nemaha	32- 4-16E	Black Gold Oil	2,650	Hunton	Seismograph
Nemaha	4- 5-13E	Keys *et al.*	2,425	Hunton	Chance
Nemaha	7- 5-13E	Palensky	3,306	Pre-Cambrian	Seismograph
Nemaha	20- 5-14E	Bow & Arrow Oil	2,418	Hunton	Chance
Nemaha	26- 6-13E	Conoco Petroleum	2,127	Hunton	Chance
Nemaha	36- 6-14E	Bow & Arrow Oil	2,580	Hunton	Chance
Nemaha	10- 6-15E	Ellis Bros.	775	Pennsylvanian	Chance
Lancaster	5- 7- 7E	Kreuger *et al.*	1,779	Viola	Chance
Otoe	3- 7- 9E	Parker Oil Company	2,126	Pre-Cambrian	Surface
Otoe	1- 8-10E	Risk *et al.*	1,840	Pre-Cambrian	Chance
Otoe	31- 9-14E	Zimmer *et al.*	2,500	Arbuckle	Surface
Cass	20-11-13E	Goldenrod Oil	1,160	Viola(?)	Chance
Sarpy	15-13-12E	Hough *et al.*	425	Mississippian(?)	Chance
		Total	58,089		
		All Total	80,529		

The Barada pool was discovered by the Skelly Oil Company's Roesch No. 1 in Sec. 36, T. 3 N., R. 16 E., Richardson County. It was completed as a 680-barrel well with no water, from the Hunton dolomite, topped at 2,432 feet and drilled to 2,518 feet. After 66 perfora-

tions at 2,443½–2,488 feet, the hole filled 2,200 feet with 30° gravity oil in 6 hours. Subsequent development, which consists of 4 additional producers, indicates a pool with productive capacity similar to the Falls City pool. However, it seems likely that the producing area may be small.

Some production was found in the Dawson pool in Sec. 9, T. 1 N., R. 14 E. The first well in this area was the Uhri Oil Corporation's Ogle No. 2, which found oil in July, 1940, and was eventually completed, producing a large proportion of water in 1941. The "pay" is found in the Hunton formation. A few other wells in the vicinity have produced small amounts of oil from this formation.

DEVELOPMENT

Table VIII shows development in Nebraska during 1941.

TABLE VIII

NEBRASKA DEVELOPMENT, 1941

				Old Wells Deepened		
Pool	*Oil*	*Dry*	*Production (Barrels)*	*Oil*	*Dry*	*Production (Barrels)*
Falls City	28	6	9,807	7	1	1,603
Dawson	1*	2	106	1	1	50
Barada	5*	0	2,415	0	0	0
Schubert	8	6	823	0	0	0
Wildcats	0*	34	0	0	0	0
Totals	42	48	13,151	8	2	1,653

* Discovery wells of Dawson and Barada pools included with pool totals.

Most of the production as well as most of the development in Nebraska was in the Falls City field which at the end of the year had produced about 2,050,000 barrels. Twenty-eight new oil wells and 6 dry holes were completed within the immediate vicinity of the field, which covers parts of Secs. 7, 8, 17, 18, 20, and 29, T. 1 N., R. 16 E., Richardson County. It does not appear at present that there will be any important extensions of this field. A second producing zone in the Siluro-Devonian rocks, commonly referred to as the Hunton limestone, was found during the year, and produced in many of the wells some of which were drilled to a lower "pay." In most instances production was without restrictions. Many of the wells were produced through casing, and naturally a large amount of water was produced with the oil. A few individual leases under this type of production have yielded fairly good returns. Acidization has increased considerably the initial production of most wells. There were no wells drilling in the Falls City pool on February 1, 1942.

Although there were 9 wells listed as producing oil in the Schubert pool on January 1, 1942, the results of development of this pool have been even less encouraging than the Falls City pool. Several of these wells are reported to be producing large quantities of water, and very little oil. There were no wells drilling in the pool in February, 1942, and it seems unlikely that there will be any great development of this area.

A few thousand barrels of oil have been sold from the two wells producing in the Dawson pool in Secs. 9 and 10, T. 1 N., R. 14 E., but this production can hardly be considered as commercial. Additional development is planned in the vicinity.

Completion of 5 wells in the Barada pool in T. 3 N., R. 16 E., indicates that a pool similar to the Falls City in production ability has been discovered. Inasmuch as production is being restricted voluntarily by the one company operating in the field to 100 barrels per day, this pool may enjoy a more prosperous production history than Falls City. A relatively sharp narrow anticlinal feature has been outlined by development to date. This structure was originally located by the core drill.

WESTERN NEBRASKA ACTIVITIES

All wildcat tests in western Nebraska in 1941 were drilled to pre-Cambrian rocks so that a complete test of the possible producing section was drilled. The 3 dry holes in Furnas County found little encouragement in the stratigraphic character of the Pennsylvanian and pre-Pennsylvanian beds. These wells served to add considerable data in the delineation of the Cambridge arch, extending across the state northwest and southeast, between the Central Kansas uplift and the Black Hills of South Dakota. The Phillips Petroleum Company's test in Dawson County likewise did not find an encouraging sedimentary column above pre-Cambrian rocks. This well as well as the Lincoln County test of Falcon-Seaboard Oil Company indicated the pre-Cambrian lies at a relatively shallow depth over a slightly larger area in Nebraska than had previously been known. The test of Bredthauer *et al.* in Valley County supplied the first accurate information on the subsurface stratigraphy of central Nebraska. Marine Pennsylvanian beds were found to be nearly 1,000 feet thick. Underlying them are sediments believed to be correlative with upper Ordovician rocks of the Salina basin. Glauconitic, sandy dolomites and sandstone correlative with upper Cambrian beds overlie pre-Cambrian in this test.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO 6 (JUNE, 1942), PP. 1086-1096, 2 FIGS.

DEVELOPMENTS IN EASTERN INTERIOR BASIN IN 1941[1]

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ABSTRACT

More wells were drilled in 1941 in Illinois and southwestern Indiana than in any previous year except 1907 when drilling reached a peak in that area. Drilling declined in western Kentucky, making the total number of completions in the Eastern Interior basin in 1941 slightly less than in 1940. Much of the 1941 drilling (both pool and wildcat) was concentrated in the deep-basin area in the region of the lower Wabash River in Illinois and Indiana where 44 new pools and 43 extensions were discovered. None of the new pools was of major size and the total output of new wells in the whole area failed to offset the decline of the older wells. Total production from the Eastern Interior basin in 1941 is estimated at 145,603,000 barrels as compared with 154,796,000 barrels in 1940, a decline of 6 per cent. Percentage of the national total was 10.3 in 1941 as compared with 11.5 in 1940.

Rocks of the Mississippian system continue to yield most of the oil in the area—91.5 per cent of the Illinois total of 133,750,000 barrels in 1941. No new Devonian production was discovered in Illinois in 1941 and the Devonian wells, which yielded an estimated 26 per cent of the Illinois total in 1940, produced only 6 per cent of the total in 1941. Pennsylvanian and Ordovician strata yielded estimated amounts of 1.7 and 0.9 per cent, respectively. Geologic studies indicate that lenticular sand conditions are important in controlling the occurrence of the oil.

INTRODUCTION

Much drilling, both pool and wildcat, many new discoveries, but no major pools, and a 6 per cent decline in production from the previous year, were features of the 1941 record of the oil industry in the Eastern Interior basin. Drilling increased slightly in Illinois and southwestern Indiana but declined in Kentucky, resulting in a slight decline for the whole basin. The following table compares the amount of drilling in 1940 and 1941.

	Number of Completed Wells	
	1940	*1941*
Illinois	3,829	3,838
Southwestern Indiana	450	463
Western Kentucky	401	314
Total for basin	4,680	4,615

Total oil production from the Eastern Interior basin in 1941 is estimated at 145,603,000 barrels as compared with 154,796,000 barrels in 1940. The 1941 production was 10.3 per cent of the total for the United States as compared with 11.5 per cent in 1940.

[1] Published with permission of the chief of the Illinois State Geological Survey. Presented before the Association at Denver, April 22–24, 1942. Manuscript received, April 10, 1942.

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FIG. 1.—Index map of the Eastern Interior basin and of Illinois basin (deep part of Eastern Interior basin).

ILLINOIS

EXPLORATORY DRILLING

A total of 591 wildcat wells were drilled in Illinois in 1941, of which 44 discovered new pools and 40 discovered extensions, that is, 1 wildcat well in 7 was successful. Nearly all of this drilling was in the southern half of the state. The distribution of the wildcat drilling in 1941 with respect to the Illinois basin (deep part of the Eastern Interior basin) is shown in Figure 2 and Table I.

It may be seen in Table II that nearly all of the 1941 discoveries were in formations of Mississippian age. The pools discovered in Pennsylvanian and Devonian formations were small. There was some development in the Devonian limestone in the Louden pool—59 producing wells by the end of the year. The discovery well for Devonian production in the Louden pool was drilled in 1937, but further de-

TABLE I

DISTRIBUTION OF ILLINOIS WILDCAT WELLS

	No. of Wildcat Wells	*No. of New Pools*	*No. of Extensions*
Illinois basin counties	356	34	37
Marginal counties	158	9	3
Outside counties	77	1	0
Total	591	44	40

FIG. 2.—Map showing distribution of Illinois wildcat drilling and discoveries in 1941 with respect to Illinois basin.

velopment did not take place until 1941. During 1941, largely during the first 6 months, 99 Devonian wells in the Salem pool were deepened to the "Trenton" limestone in the Ordovician system.

Mississippian formations continue to yield most of the oil in Illinois—an estimated 91.5 per cent in 1941. The Devonian limestone, which produced an estimated 26 per cent of the Illinois total in 1940, produced only about 6 per cent of the total in 1941. Pennsylvanian and Ordovician strata yielded estimated amounts of 1.7 and 0.9 per cent respectively during 1941.

TABLE II

GEOLOGICAL DISTRIBUTION OF DISCOVERIES IN ILLINOIS IN 1941

System or Series	*Formation or "Sand"*	*No. of New Pools*	*No. of Extensions*	*Total No. of Discoveries*
Pennsylvanian	(Unnamed)	1		1
Pennsylvanian	Buchanan	2		2
Upper Miss. (Chester)	Palestine	2		2
Upper Miss. (Chester)	Waltersburg	1	1	2
Upper Miss. (Chester)	Tar Springs	4	7	11
Upper Miss. (Chester)	Cypress	4	4	8
Upper Miss. (Chester)	Paint Creek		2	2
Upper Miss. (Chester)	Bethel	4	8	12
Upper Miss. (Chester)	Aux Vases	6	5	11
Lower Miss. (Iowa)	Rosiclare	2		2
	Fredonia "McClosky"	17	14	31
Devonian		1*		1
		44	41	85**

* Gas well, shut in.

** One well, discovering an extension of the Clay City pool, is producing from two sands, the Cypress and Bethel, making the total of discovery wells 84 instead of 85.

GEOLOGIC FEATURES REVEALED BY NEW DRILLING

Structural and stratigraphic studies now in progress indicate that the amount of closure on top of the Glen Dean limestone for many of the new pools discovered in 1941 is small. The lensing-out of the oil sand determines the updip boundary of the producing area in some instances, one of which is described in another paper on this program. The Johnsonville pool, the largest new pool developed during the year, is located on a dome of about 100 feet of closure on top of the Glen Dean limestone and covers an area of about 7 square miles.

The Benton pool is located on a north-plunging anticline of about 40 feet of closure on the top of the producing sand which is the Tar Springs sandstone. The producing area is bounded on the south on the highest part of the structure by tight sand, whereas on the north, east, and west the boundary parallels the structure contours. An exceptional condition was revealed in the Omaha pool where sills of igneous rock occur at several horizons, including that of the producing sand.

TABLE III

IMPORTANT DEEP TESTS IN ILLINOIS IN 1941

County	*Pool or Wildcat*	*Location*	*Company and Farm No.*	*Total Depth (Feet)*	*Deepest Formation Tested*	*Top (Feet)*	*Remarks*	*Date Completed*
Adams	Wildcat	12- 2S - 8W	Schachtsick—Reichart 1	901	St. Peter	820	Dry	5/20/41
Bond	Wildcat	28- 4N- 4W	Farrelly—Kyle 1	2,150	Devonian	2,115	Dry	5/ 6/41
Bond	Wildcat	21- 6N- 2W	Schwarz & Shell—Studebaker 1	3,206	"Trenton"	3,144	Dry	8/ 5/41
Bond	Wildcat	15- 6N- 2W	Texas—Mull 1	2,476	Devonian		Dry	7/15/41
Bond	Wildcat	1- 4N- 4W	Haines & Jackson—Hunter 1	2,539	Ste. Genevieve	2,420	Dry	3/ 4/41
Champaign	Wildcat	18-17N-11E	Union Products Petrol. Co.—Messman 1	1,850	"Trenton"	1,683	Dry	5/20/41
Champaign	Wildcat	18-22N- 8E	Robinson—Springer 1	1,404	"Trenton"	1,255	Dry	10/28/41
Christian	Wildcat	24-12N- 1W	Olson Drilling Co.—Tex 1	2,720	Devonian	2,540	Dry	6/10/41
Christian	Wildcat	26-15N- 2W	Marlow *et al.*—Howell 1	2,016	Devonian	1,915	Dry	7/29/41
Clark	Westfield	18-11N-14W	Harvey—Phillips 1	1,560	Devonian-Silurian		Dry	6/24/41
Clark	Wildcat	1- 9N-14W	Swan-King—Claypool	1,687	Devonian	1,622	Dry	12/16/41
Clay	Clay City Cons.	4- 2N- 8E	Pure—Moseley "B" 3	4,840	Devonian	4,669	Dry	10/21/41
Clinton	Wildcat	27- 3N- 1W	Obering *et al.*—Yantis 1	2,871	Devonian	2,802	Dry	4/ 8/41
Clinton	Wildcat	22- 1N- 5W	Gerson *et al.*—Billhart 1	3,217	"Trenton"	2,955	Dry	8/ 5/41
Coles	Wildcat	33-14N-10E	Allen & Sherritt—Taylor 1	1,143	Devonian		Dry	3/11/41
Coles	Wildcat	36-14N-10E	East Oakland Syndicate—Temple 1	2,290	"Plattin"	2,145	Dry	2/25/41
Crawford	Oblong	7- 6N-13W	Powers—Kirtland 1	3,110	Devonian	3,095	Dry	5/13/41
Douglas	Wildcat	33-16N- 9E	Illinois Mid-Continent—Bragg 1	700	Devonian		Dry	10/28/41
Dupage	Wildcat	2-40N- 9E	I.C.R.—Bartlett	1,175±	Franconia		Dry	12/30/41
Edgar	Wildcat	19-15N-13W	Leonard—Baker 1	960	Devonian	890	Dry	9/30/41
Fayette	Wildcat	13- 4N- 1W	Angelo-Twelve Oil Co.—Oates 1	3,056	Devonian	2,942	Dry	1/14/41
Fayette	Louden	16- 8N- 3E	Whisenant—Lilley 25-D	3,131	Devonian	3,063	1243BOF	5/27/41
Fulton	Wildcat	11- 7N- 1E	Lee Twp. Oil Co.—Walker 1	955	"Trenton"	953	Dry	5/13/41
Hancock	Wildcat	28- 4N- 5W	Tate—Rice 1	2,085	Dresbach		Dry	4/29/41
Jackson	Wildcat	9- 8S - 3W	Magnolia Petrol. Co.—Smith Heirs 1	3,893	"Trenton"	3,705	Dry	1/21/41
Johnson	Wildcat	24-11S - 3E	Benedum & Trees Oil Co.—Cavitt 1	4,250	Devonian	4,097	Dry	3/11/41

TABLE III (*Continued*)

County	*Pool or Wildcat*	*Location*	*Company and Farm No.*	*Total Depth (Feet)*	*Deepest Formation Tested*	*Top (Feet)*	*Remarks*	*Date Completed*
Knox	Wildcat	10-10N- 3E	Davis—Byland 1	1,200	"Trenton"	967	Dry	6/ 3/41
Lawrence	Wildcat	20- 3N-12W	Robinson—Sauers 1	5,013	"Trenton"	4,862	Dry	2/25/41
McLean	Wildcat	28-22N- 1E	Funks Grove Oil & Gas Co.—Crawford 1	2,115	"Trenton"	1,995	Dry	5/27/41
Macoupin	Wildcat	1- 9N- 7W	Bridges *et al.*—Feiker 1	1,613	Devonian	1,505	Dry	4/ 1/41
Madison	Wildcat	27- 5N- 8W	Kiskadden—Fischer 1	1,955±	Decorah	1,945(?)	Dry	11/ 4/41
Madison	Wildcat	22- 3N- 6W	Wickwire *et al.*—Ellis 1	1,410	Devonian	1,363	Dry	2/11/41
Montgomery	Wildcat	28- 9N- 4W	Brown *et al.*—Luddeke 1	2,008	Devonian	1,970	Dry	5/20/41
Montgomery	Wildcat	10- 9N- 2W	Hoover—Battles 1	2,598	Devonian	2,519	Dry	5/20/41
Montgomery	Wildcat	20-10N- 2W	Detrick—Banes 1	2,528	Devonian-Silurian	2,298	Dry	7/ 1/41
Montgomery	Wildcat	3-10N- 2W	Benedum & Trees—Janssen Heirs	3,237	"Trenton"	3,144	Dry	8/19/41
Montgomery	Wildcat	28- 9N- 4W	Brown & Hager—Luddeke 1	1,810	Devonian		Dry	2/18/41
Morgan	Wildcat	2-13N-10W	Hunt—Cuddy 2	1,512	"Trenton"	1,380	Dry	4/15/41
Morgan	Wildcat	1-16N-11W	Measley *et al.*—Crum 1	1,200	"Trenton"	1,120	Dry	4/15/41
Morgan	Wildcat	28-13N- 8W	Magnolia Petrol.—Keplinger 1	1,765	"Trenton"	1,585	Dry	9/ 9/41
Moultrie	Wildcat	31-14N- 4E	Olson Drill. Co.—Ekiss 1	2,947	Devonian-Silurian	2,768	Dry	6/24/41
St. Clair	Wildcat	31- 3S - 6W	Alspach—Smith 1	1,715	Devonian	1,681	Dry	7/15/41
St. Clair	Wildcat	2- 2S - 9W	Magnolia Petrol.—Probst 1	1,450	"Trenton"		Dry	7/15/41
St. Clair	Wildcat	32- 2N- 7W	Morris—Rasp 1A	2,075	"Trenton"	1,947	Dry	10/14/41
St. Clair	Wildcat	26- 1N- 9W	Gass and Frazier—Hahn 1	1,500	"Trenton"	1,469	Dry	11/25/41
Scott	Wildcat	27-13N-13W	Bedell—Adams 1	1,050	St. Peter	875	Dry	3/25/41
Shelby	Wildcat	2-13N- 3E	Olson Drill. Co.—Atkinson 1	2,922	Devonian	2,822	Dry	7/ 1/41
Shelby	Wildcat	36-13N- 3E	O. C. Brunsvold—Harley-Yantis 1	3,061	Devonian	2,970	Dry	2/ 4/41
Vermillion	Wildcat	30-18N-13W	Sylvestre—Trisler 1	1,775	Devonian	1,428	Dry	6/10/41
Warren	Wildcat	11- 9N- 1W	Monarch Oil Co.—Hoadley 1	538	Devonian-Silurian		Dry	9/ 3/41
Washington	Wildcat	32- 2S - 4W	Bergundthal—Dement 1	2,395	Devonian	2,347	Dry	11/25/41
Clinton	Bartelso	9- 1N- 3W	Mosebach-Schlarmann 1	4,213	St. Peter	4,175	Dry	4/22/41
Fayette	Louden	21- 8N- 3E	Carter Oil Co.—Brauer 6D	4,679	St. Peter	4,421	Dry	11/24/41

RESULTS OF DEEP TESTING

Most of the deep drilling (see Table III) was located in counties west of the Illinois basin and there was little in the basin itself. The only deep test in the central part of the basin was the Pure Oil Company's Mosely No. 33, in the W. ½, NW. ¼, SW. ¼ of Sec. 4, T. 2 N., R. 8 E., Clay County, which tested the Devonian limestone in the Clay City field (top of Devonian limestone 4,669 feet; total depth, 4,840 feet). The well was deepened by cable tools from a former depth of 3,118 feet in the Ste. Genevieve limestone. At 4,820 feet the hole was bailed dry. Between 4,820 feet and the total depth of 4,840 feet, salt water containing hydrogen sulphide was encountered, which rose to a height of 1,400 feet in the hole. A sample analyzed by the Illinois Geological Survey had a total dissolved mineral content of 130,776 parts per million. No showings of oil or porosity were noted in the limestone down to the top of the Dutch Creek sandstone. This well was located about one mile west of the crest of the Clay City anticline, as indicated by structural data on the Glen Dean limestone. In the absence of even a showing of oil, the chances for oil in the Devonian limestone on this structure seem slight.

The St. Peter sandstone was tested in the Louden field, Fayette County, by the Carter Oil Company's J. Brauer No. 6D, in the center of the SE. ¼, SE. ¼ of Sec. 21, T. 8 N., R. 3 E. The total depth was 4,679 feet. The well was plugged back to 3,026 feet to produce from the Devonian limestone. Streaked oil-saturation was encountered in the Kimmswick ("Trenton") limestone from 3,842 to 3,943 feet. The top of the "Trenton" was at 3,824 feet. A drill-stem test recovered no oil. The top of the St. Peter sandstone was at 4,421 feet. A core from 4,464 to 4,486 feet consisted of 8 feet of tight sandstone overlying 13 feet of porous friable sandstone and had no oil-showing. A drill-stem test at this depth recovered 450 feet of muddy water and 3,950 feet of clear water.

Numerous tests to the Devonian and Trenton were drilled in the marginal areas west and north of the Illinois basin. Other noteworthy deep tests were a "Trenton" test in Jackson County, a Devonian test in Johnson County, and two on the LaSalle anticline in the Southeastern Illinois field, one to the Devonian in Crawford County and one to the "Trenton" in Lawrence County.

SOUTHWESTERN INDIANA

The following information on developments in southwestern Indiana was furnished by Ralph E. Esarey, State geologist, and Robert G. Reno, State gas supervisor, Indianapolis, Indiana.

During 1941, Indiana experienced a marked increase in drilling activity and prospecting over former years. Much of the development was concentrated in the southwestern part of the state which lies in the Eastern Interior coal basin. More than half of all wells drilled were located in Posey and Gibson counties, where the largest fields in the state have been opened in recent years. However, activity was widespread, with considerable core drilling and prospecting in the northern part, which includes the south flank of the Michigan basin. The old "Trenton" field of northeastern Indiana is receiving some attention as well as the Kankakee arch in the northwestern part.

During the year 552 wells were drilled, of which 411 were field locations and 141 were wildcats. This represents an increase of 32 wells over the year 1940. Of the field wells drilled, 260 were oil wells, 57 gas wells, and 94 dry holes. The wildcat wells included 16 oil wells that were potential pool openers or extensions, 3 commercial gas wells in the same area, and 122 dry holes. Approximately 25 per cent of all drilling was wildcat, with 11 per cent of it finding oil and 5 per cent gas.

Total production for the year will exceed 7 million barrels, which is the greatest since 1906. At the end of the year, 53 field wells and 34 wildcats were being drilled.

The Griffin field, in Gibson and Posey counties, continued to lead in drilling activity, with 157 completions. The field is practically defined on the east side and produces from five, or possibly six, pay zones, all of Chester or of Upper Mississippian age. The Devonian has not yet been tested. The total production for the field in 1941 is estimated in excess of 3 million barrels. The Ribeyre Island field, near New Harmony, second largest producer, reported only two completions during the year. An extension of the Heussler field, also in Posey County, was discovered and resulted in 11 new completions and 4 dry holes. It ranks third in the state as a producing area, with practically all oil coming from the Waltersburg and Tar Springs sands. Two new fields were discovered in Posey County during the year, in addition to some good prospects. The Mt. Vernon pool, T. 7 S., R. 14 W., was opened by the Carter Oil Company's W. D. Maier No. 1, which found saturation in the Waltersburg and Tar Springs. The initial test was reported as 1,000 barrels daily. Seven other producers and no dry holes have been drilled to date. The Lamott pool, in T. 7 S., R. 12 W., produced 55 barrels from the Tar Springs at about 1,950 feet. One additional well has been completed and one dry hole drilled in the area. One well in the Welborn-Switch area found commercial oil in the Cypress at 2,500 feet, with an initial production of 33 barrels. The second well

drilled was dry. To complete the operations in Posey County, 4 completions were made in the Vienna pool in the Mansfield sandstone, and the College field was enlarged by three producers in the Aux Vases sandstone.

In the Caborn field, the Tar Springs and Mansfield were opened as new pay zones with initial productions of more than 100 barrels.

Gibson County had the following discoveries during the year.

The Patoka field was opened by a 300-barrel well in the McClosky sand.

A possible extension of the Mt. Carmel field was opened by a 24-barrel producer on the Indiana side. Another good prospect is known as the Johnson field, where production was found in the Mansfield sandstone at 1,105 feet. The area is in Sec. 31, T. 2 S., R. 12 W. Considerable excitement resulted from the McClosky test near Hazelton which had a reported initial production of more than 200 barrels. A second completion has resulted and several new locations are started. North of Francisco, a new area was opened by the Brown-Creselius well which made 25 barrels on the first production test.

Vanderburgh County had one new pool opened, known as the Vernon pool, ½ mile east of the Heussler field. Six completions have been made in the Mansfield sandstone, with initial flows of 25–30 barrels.

The Hatfield pool was opened in Spencer County, with the discovery well making approximately 100 barrels in the Waltersburg sand. The area is "spotty"; it has seven producers and several dry holes. Drilling was active prior to the new Federal spacing law.

The North Glendale gas field in Daviess County was opened and partly developed. There are now 7 producing wells in the Cypress, averaging more than 500,000 cubic feet daily, each.

Pike County has a good prospect, which may be a pool opener, in the Patberg No. 1 which was reported as making 65 barrels from the Cypress. The small town of Stendal is near by, the name of which will be used for the field.

The Laconia gas field, Harrison County, where production comes from the New Albany shale, had 6 completions and 3 dry holes.

Decatur County had 12 gas wells completed in the "Trenton," and Randolph County had 4 "Trenton" gas wells completed in the Unionport field. Exclusive of Decatur and Randolph counties, there were 13 gas wells, 1 oil well, and 7 dry holes drilled in the old "Trenton" field. An attempt is being made to revive the old Horton oil field in Hamil-

ton County, north of Indianapolis, where a 5-barrel "Trenton" well was completed.

Interest continues to grow in northern Indiana. A Devonian well, reported at 47 barrels, opened the so-called Elkhart field in Elkhart County, which has been disappointing so far.

The Anderson-Erb produced ½ million cubic feet of gas from the "Niagara" or Lower Silurian, in the Old Francisville pool in Pulaski County. No further production has been found near the well.

In several other areas of the state small gas wells, showing prospects of new pools, were completed. In northern Indiana, core-testing and leasing has surpassed all other years. Large blocks of leases continue to be assembled and a few production tests have been made.

With increased wildcat drilling probably resulting from recent restrictions on drilling in pools, several new discoveries should be found in 1942.

WESTERN KENTUCKY

The following information on developments in western Kentucky was furnished by D. J. Jones, State geologist, Lexington, Kentucky.

Oil and gas development in Kentucky west of the Cincinnati arch for 1941 has decreased to some extent from that of the preceding year. Three hundred fourteen tests were reported, of which 153 were oil wells, 11 were gas wells, and 150 were dry holes as compared with 401 reported for 1940, of which 175 were oil wells, 10 were gas wells, and 216 were dry holes.

Production for the state, due to the discovery of no large flush pools, decreased to a level of 4,852,618 barrels as compared with 5,178,814 barrels for the year 1940.

New productive territory was confined largely to the extension of proved areas. The deepening of old producers resulted in some additional production in deeper pay zones.

An extension of the Legrande pool in Hart County resulted in new "Corniferous" production.

New discoveries in Union and Webster counties have increased interest in those counties. Production was found in sands of Pottsville age. These pools are in the early stages of development.

Completions were reported from 21 counties testing formations from Pennsylvanian to Lower Ordovician.

The sands of the Chester series have furnished most of the new production. These sands are found at shallow depths and offer an attractive play to the small company and individual operator.

The Devonian and Silurian beds, particularly in the shallow areas east and south of the western coal basin, have had some drilling activity. This territory, because of the shallow depth to the "Corniferous," offers an attractive play.

As a result of no showings of either oil or gas in any of the tests to the Knox dolomite in western Kentucky, there has been very little interest manifested in drilling to the deeper formations. Two tests to the Knox were reported.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP 1097-1109, 1 FIG.

OIL AND GAS DEVELOPMENTS IN MICHIGAN DURING 1941[1]

R. P. GRANT[2]
Lansing, Michigan

ABSTRACT

During 1941, the Basin district was the most active in Michigan due chiefly to development in the Detroit River (Devonian) formation in the Reed City field in western Osceola County, the Headquarters Traverse (Devonian) field in southern Roscommon County, and extensive development of "Michigan stray" (Mississippian) gas fields in Osceola, Missaukee, and Clare counties.

Ten new oil fields and extensions and six new gas fields were discovered during the year. The Basin district was most important insofar as new developments were concerned. The most important oil discovery in southwestern Michigan was the West Hopkins Traverse (Devonian) field in Allegan County. Actual oil production dropped approximately 17 per cent below 1940.

More gas wells were drilled in 1941 than in any year since 1936. Gas production reached a new maximum with a 6 per cent increase over 1940. The Gulf Refining Company's Bateson No. 1 in the Kawkawlin field in Bay County was drilled to 10,445 feet into the St. Peter (Ordovician) sandstone, but was plugged back to 7,800 feet and kept as a condensate well. Late in December, gas was discovered in Calhoun County in the Traverse (Devonian) limestone, opening an entirely new area to development.

The Panhandle and Eastern Pipeline Company began construction of a gas transmission line approximately 250 miles long. The line will extend from the Michigan Gas transmission line in the southeastern corner of Lenawee County northward to Pleasant Lake in Washtenaw County. One branch will be laid west to Kalamazoo, the other will extend north to Flint and Saginaw. Construction was begun at Saginaw and the line is expected to be completed during 1942.

Geophysical prospecting and core testing were carried on at a brisk rate particularly in the northern and south-central parts of the Southern Peninsula.

INTRODUCTION

The purpose of this paper is to discuss briefly the more important developments in the petroleum industry in Michigan during 1941. The number of wells completed dropped from 1,181 in 1940 to 951. This reduction appears to be due to transfer of interest from the shallow southwestern Michigan district to the deeper part of the Basin district. The total number of feet drilled in the year was 2,002,341 as compared with 2,304,855 in 1940. There were 16 oil and gas discoveries and major extensions in 1941. Two discoveries served to bolster the oil reserves—the new Detroit River producing formation in the Reed City pool, Osceola County, and the Headquarters Traverse field in Roscommon County. Discovery of natural gas in Calhoun County in the Traverse formation, late in the year, may be the forerunner of a new producing district in the state.

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, March 21, 1942.

[2] Petroleum geologist, Michigan Department of Conservation, Geological Survey Division.

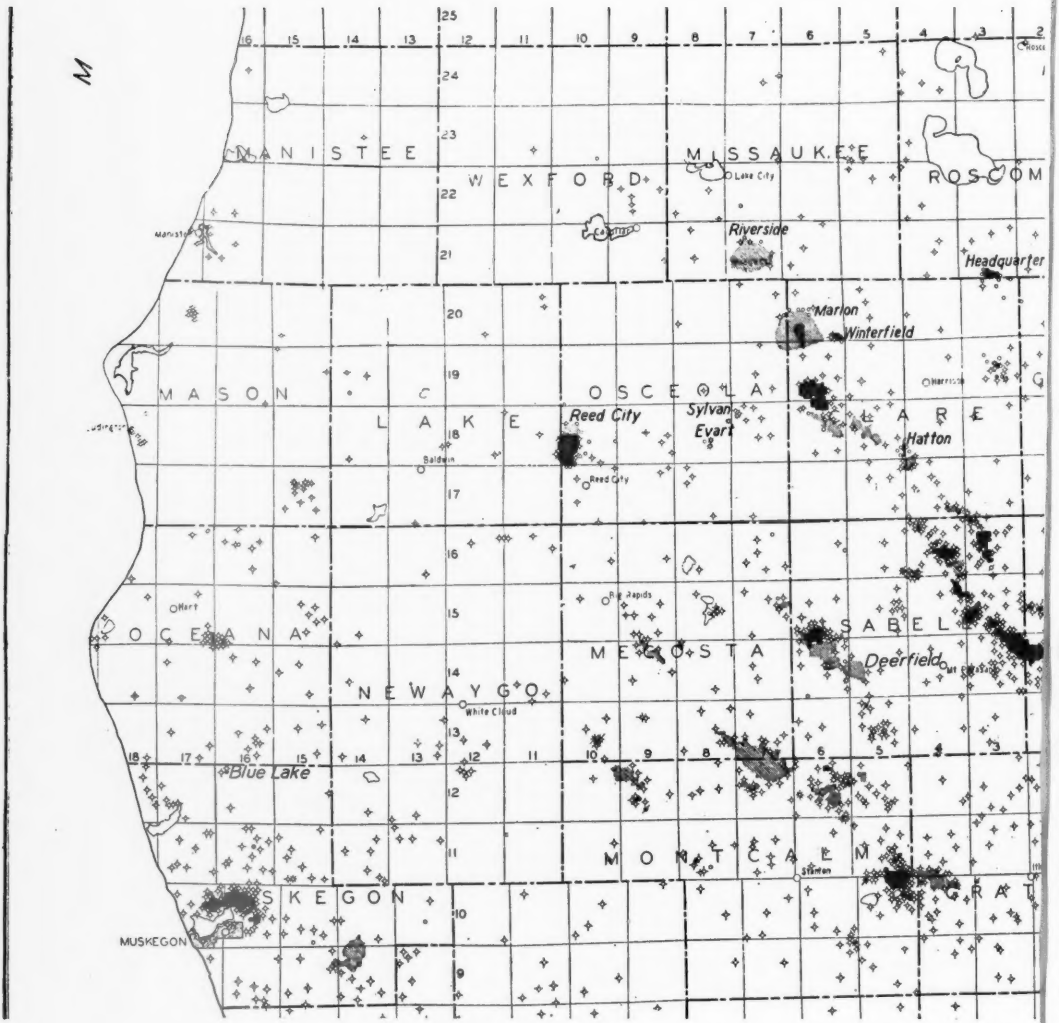
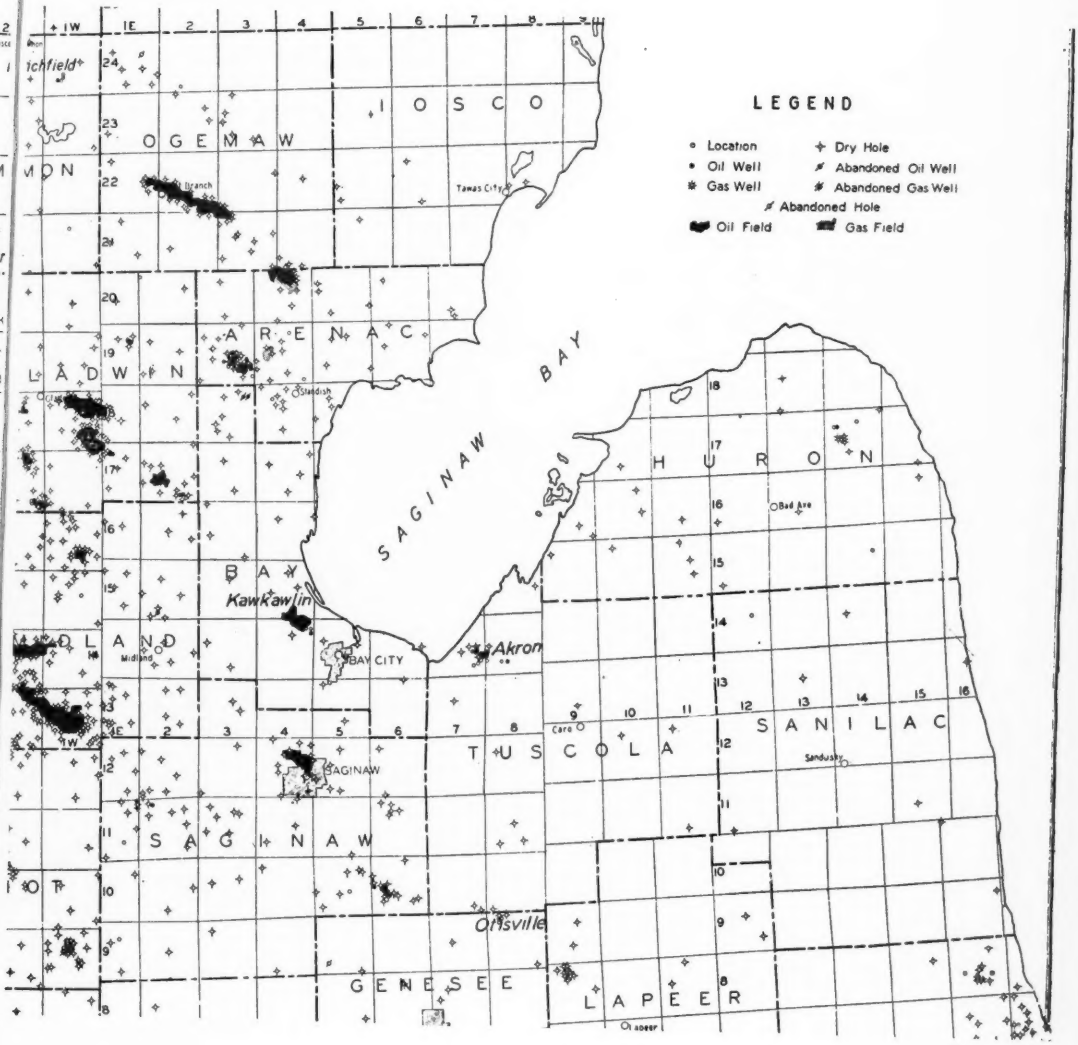


FIG. 1.—Upper section


LEGEND
Location
Oil Well
Gas Well
Dry Hole
Abandoned Oil Well
Abandoned Gas Well
Abandoned Hole
Oil Field
Gas Field
IOSCO
OGEMAW
ARENAC
BAY
SAGINAW BAY
HURON
SANILAC
TUSCOLA
SAGINAW
GENESEE
LAPEER
Tawas City
Standish
Kawkawlin
BAY CITY
Akron
Bad Axe
Caro
Sandusky
Otisville
Oscoda
Midland
Branch
1W
1E

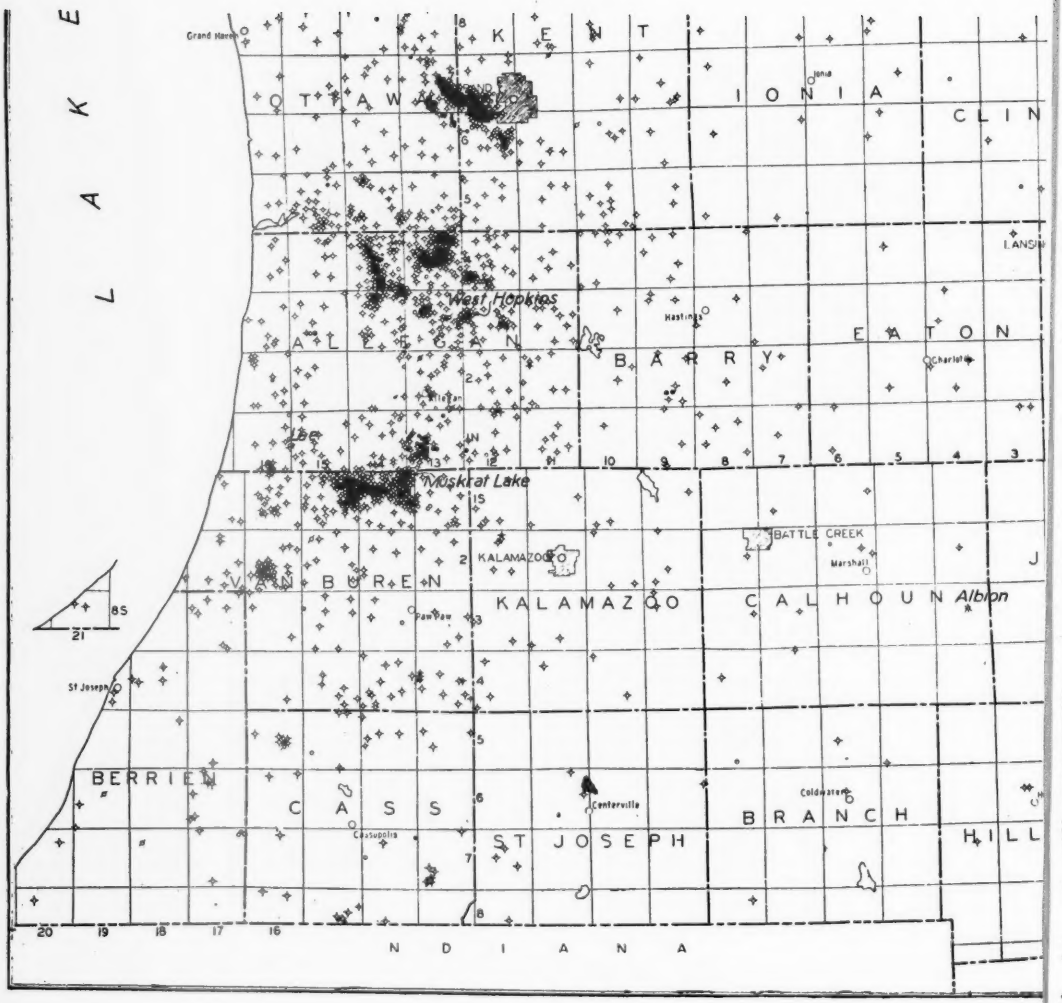
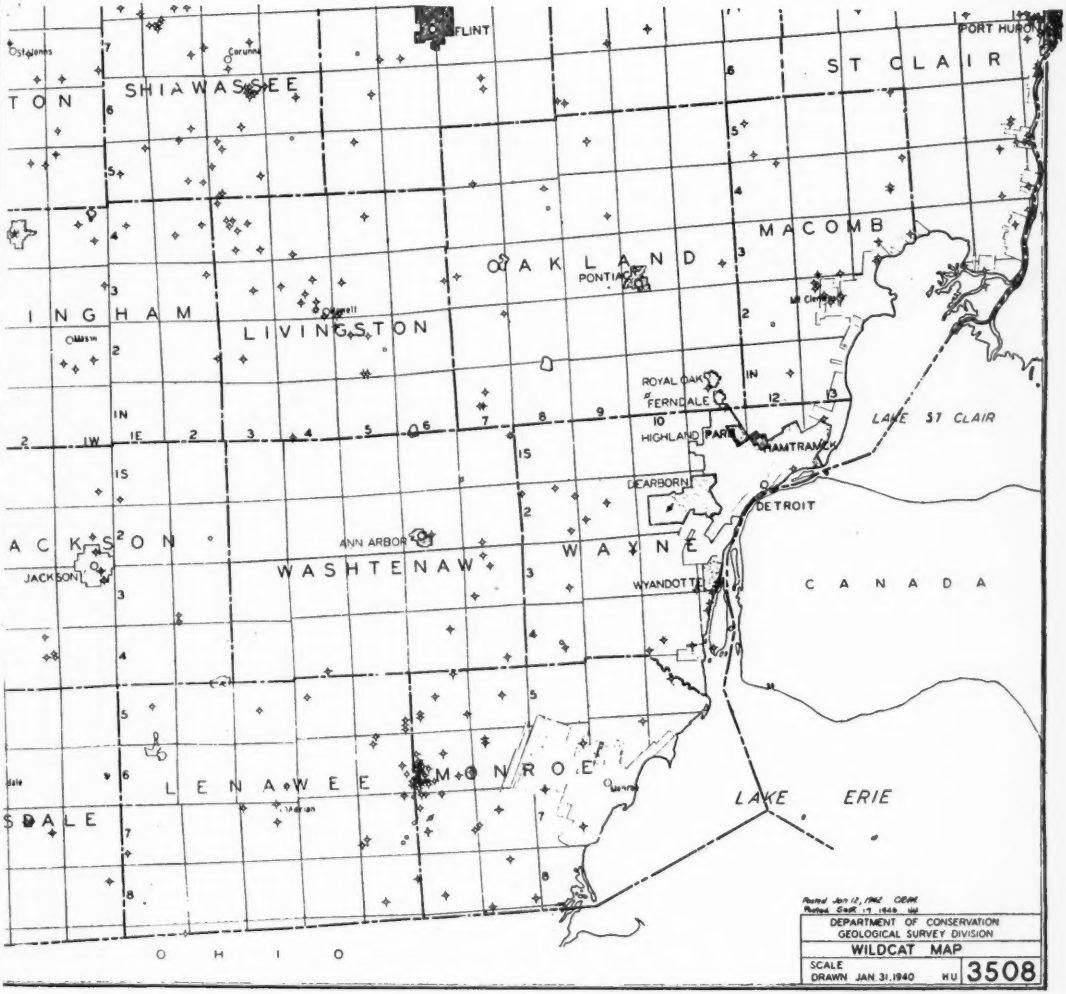


FIG. 1.—Lower section.


FLINT
PORT HURON
ST CLAIR
SHIAWASSEE
MACOMB
OAKLAND
PONTIAC
LIVINGSTON
ROYAL OAK
FERNDALE
HIGHLAND PARK
HAMTRAMCK
LAKE ST CLAIR
DEARBORN
DETROIT
ANN ARBOR
WASHTENAW
WAYNE
JACKSON
WYANDOTTE
CANADA
LENAWEE
MONROE
LAKE ERIE
OHIO
Posted Jan 12, 1942 CEW
Posted Sept 15 1949 HH
DEPARTMENT OF CONSERVATION
GEOLOGICAL SURVEY DIVISION
WILDCAT MAP
SCALE
DRAWN JAN 31 1940
HU 3508

Natural Gas

There was greater development in natural gas in Michigan during 1941 than in any year since 1936. Of the 97 new gas wells, 70 were drilled in Clare, Isabella, and Osceola counties. Gas production was 6 per cent greater than in 1940, reaching a new peak of 15,092,464,000 cubic feet. Natural-gas activity was due chiefly to development of the Reed City field in Osceola County, the Marion field in Clare and Osceola counties, and to the discovery and partial development of the Deerfield pool in western Isabella County, an extension of the older Broomfield gas area.

Reed City gas field (Osceola County)

The Reed City gas field, discovered in November, 1940, was expanded in 1941. It has 24 producing wells and comprises 4,100 acres in Secs. 8, 17, 18, 19, 20, 29, 30, 31, and 32, T. 18 N., R. 10 W. Gas is produced from the "Michigan stray" sandstone at depths ranging from 1,150 to 1,250 feet. Pay thickness appears to range from 5 to 8 feet. A 6-inch transmission line was constructed from the field to Big Rapids, and thence to the Austin field, connecting the field to an existing line.

Marion field (Clare and Osceola counties)

The Marion field was enlarged by 16 wells and now covers approximately 5,000 acres in the southwestern part of T. 20 N., R. 6 W. A $12\frac{3}{4}$-inch transmission line begun in 1940 was completed this year, connecting the Riverside field in Missaukee County and the Marion field with existing lines.

Riverside (Missaukee County)

In the Riverside field, five wells were drilled during the year and the field contains approximately 1,600 acres. Further development is expected since a transmission line is now available.

Deep River (Arenac County)

The discovery well in the Deep River field was T. F. Caldwell's Mutch No. 1, in the NE. $\frac{1}{4}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$ of Sec. 17, T. 19 N., R. 4 E., which was drilled in 1936. The well was drilled to the Dundee formation but was later plugged back to the Berea sandstone and saved as a gas well with an estimated open flow of 100,000 cubic feet. Nothing further was done in the area until 1941 when four wells were drilled. The average thickness of the "pay" is 6 feet and the depth varies from

1,500 to 1,550 feet. The largest well in the area, which in December covered approximately 800 acres, had an initial open flow of 3,466,000 cubic feet.

DEERFIELD AND BROOMFIELD (ISABELLA COUNTY)

The Deerfield pool, which is probably a southeasterly extension of the older Broomfield gas area, was opened in March, 1941, by Burriss and Quinlan's Winesburg No. 1 in Sec. 20, T. 14 N., R. 5 W., in the "Michigan stray" sandstone at the depth of 1,292 feet with an initial open flow of 22,000 cubic feet. The discovery well was later deepened to the Dundee formation and plugged as non-commercial. Subsequently, the field was expanded by 12 wells to approximately 2,000 acres. This area was connected with lines in Broomfield by a 2-inch line. Further development is expected. Six wells were completed in Broomfield in the general area adjacent to the Deerfield extension.

KAWKAWLIN FIELD (BAY COUNTY)

In August, the Gulf Refining Company completed the deepening of Bateson No. 1, in the center of S. $\frac{1}{2}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$ of Sec. 2, T. 14 N., R. 4 E. in the Kawkawlin field. The well set a new record for depth, at 10,445 feet. It was drilled into the St. Peter sandstone (Orodovician) but was not commercially productive in the deeper pay zones. The well was plugged back to 7,800 feet in the basal Salina and was kept as a condensate well.

UNDEVELOPED GAS DISCOVERIES

The Regal Dutch Petroleum Company's Heasley No. 1, Sec. 21, T. 4 N., R. 13 W., Allegan County, was deepened, October 21, 1941, to the Trenton formation but was plugged back to 3,792 feet in the Salina, at which depth gas is being produced. Initial well-head pressure was reported to be 1,150 pounds per square inch and open-flow rating was 304,000 cubic feet.

The Evart field, Osceola County, was discovered, November 17, 1941, by the Taggart Brothers Company's Wirth No. 1, Sec. 22, T. 18 N., R. 8 W., in the "Michigan stray" sandstone at a depth of 1,467 feet, with an initial open flow of 388,000 cubic feet. Two other producing wells were drilled in the area which has possibilities for future development.

The Sylvan gas field was discovered by the Turner Petroleum Company's Gas Unit No. 1, Sec. 7, T. 18 N., R. 7 W., Osceola County, on August 5, 1941, at a depth of 1,528 feet in the "Michigan stray" with an initial open flow of 1,920,000 cubic feet. One other well was completed by the end of the year.

TABLE I

MICHIGAN PRODUCTION BY FIELDS[1]

Field	*1941 Production (Barrels)*	*Accumulative Production (Barrels)*	*Recovery Barrels Per Acre*
Saginaw	23,018	1,374,074	916
Muskegon	29,878	6,686,219	2,388
Mount Pleasant	383,503	21,520,366	5,186
Leaton	132,064	2,882,896	3,432
Vernon	159,022	4,285,466	5,714
Porter	1,136,076	31,674,155	7,315
Yost	405,543	6,516,117	3,242
Ogemaw	405,646	4,556,559	1,713
Edmore	14,818	419,145	4,657
Birch Run	9,617	190,227	732
Sherman	288,238	3,890,018	4,471
Beaverton	27,504	627,999	2,730
Mount Haley	1,288	30,133	
Crystal	76,505	7,148,319	3,928
Deerfield	84,783	236,933	1,580
South Buckeye	129,690	3,688,983	1,962
South Beaverton	120,424	231,203	1,156
Currie	6,275	149,585	
Clayton	254,350	3,461,998	5,868
Winfield	29,224	40,212	
North Buckeye	535,503	14,307,216	5,461
Salem	292,089	2,784,108	1,326
Adams	1,117,892	1,551,278	2,927
Bentley	99,055	636,825	1,633
Lakefield	913	4,643	
Trowbridge	52,656	83,886	233
Edenville	64,900	1,094,166	3,126
Kawkawlin	184,651	226,756	613
Pine	4,424	27,913	
Monterey	32,176	354,587	1,266
Dorr	23,051	264,131	1,016
Clare City	5,504	16,790	
Akron	75,186	90,507	
Diamond Springs	54,416	709,834	1,731
Temple (Freeman-Redding)	1,940,588	12,157,628	4,863
Bloomingdale	529,187	5,415,979	3,925
Overisel	386,279	1,857,225	1,198
Wise	378,021	1,503,832	1,419
Mill Lake	85,044	371,828	1,126
Columbia	161,686	1,863,507	1,901
Walker	1,291,690	8,331,194	1,752
New Salem	586,124	2,954,613	3,046
Hopkins	14,600	107,536	460
Bangor	120,494	292,616	1,626
South Tallmadge	172,893	210,263	382
Wyoming Park	21,667	88,464	
Porter (Van Buren)	1,620	1,790	
Sec. 18, Sherman	259	975	
Holland	2,648	11,547	
Hope	1,489	3,315	
Dalton	823	1,515	
Grout	8,412	12,289	
Geneva (Van Buren)	6,113	10,048	
Casco	2,200	2,509	

[1] Fields which had no production in 1941 are not listed.
Fields are listed approximately in the order of discovery.

TABLE I (*Continued*)

Field	*1941 Production (Barrels)*	*Accumulative Production (Barrels)*	*Recovery Barrels Per Acre*
Winterfield	1,101,337	1,109,722	1,850
Reed City	2,754,365	2,756,282	1,198
Sec. 5, Tallmadge	1,127	1,647	
Sec. 11, Overisel	4,577	4,665	
Blue Lake	26	26	
Crystal (Oceana)	487	487	
Headquarters	314,770	314,770	1,431
Muskrat Lake	112,409	112,409	250
Edwardsburg	38	38	
Richfield	1,577	1,577	
Otisville	1,002	1,002	
West Hopkins	87,353	87,353	460
Hatton	5,449	5,449	
Lee	1,730	1,730	
Akron (Sec. 28, T. 14 N., R. 8 E.)	751	751	
Total Michigan production for 1941—		16,358,717	
Total accumulative production since 1925—		161,593,286	

The Continental Oil Company's Turner No. 1, Sec. 15, T. 3 S., R. 4 W., Calhoun County, which was completed, December 27, 1941, at the depth of 1,609 feet in the Traverse limestone, with an initial open flow of 10,500,000 cubic feet, promises to open an entirely new area to exploration for both oil and gas. Reported well-head pressure was 720 pounds per square inch.

PANHANDLE AND EASTERN GAS TRANSMISSION LINE

The Panhandle and Eastern Pipeline Company received permission to construct a gas transmission line totaling 250 miles. The proposed line will begin at the Michigan Gas Transmission Corporation line in the southeastern corner of Lenawee County as a 20-inch line, will go north to Pleasant Lake in Washtenaw County where one branch will go westward, reaching Kalamazoo as a 12-inch line. The western branch will connect with Battle Creek and Jackson. The northern branch will go to Flint and Saginaw, passing through Washtenaw, Oakland, Genesee, and Saginaw counties, connecting northwest of the city of Saginaw with the existing Consumers Power Company's line. A short branch will extend eastward in Oakland County to the vicinity of the City of Birmingham. Construction was started during 1941 on the Saginaw-Flint portion of the line. Plans are to complete the entire line during 1942 if possible.

OIL

The Basin was the most active district in Michigan throughout the year with important development in Reed City, Headquarters,

TABLE II

SUMMARY OF OPERATIONS, BY DISTRICTS, IN MICHIGAN DURING 1941

Area	Permits Issued	Wells Completed	Oil Wells	Initial Production Oil (Barrels)	Gas Wells	Initial Production Gas (1,000 Cubic Feet)	Dry Holes	Total Production—1941	
								Oil (Barrels)	Gas (1,000 Cubic Feet)
Southwestern Michigan	378	410	192	14,498	7	16,393	211	4,044,716	1,429,031
Basin	615	485	246	476,752	89	451,937	150	12,227,729	13,663,433
All other parts of state	51	56	3	150	1	135	52	86,272	
Total	1,044	951	441	491,400	97	468,465	413	16,358,717	15,092,464

and Kawkawlin fields. Much emphasis was placed on core-testing and geophysical exploration in the Basin. Oil production (Table I) dropped 17 per cent from 1940. Oil wells for the year numbered 441. Table II shows comparative distribution of wells between the two major producing areas of the state.

BASIN DISTRICT

REED CITY (OSCEOLA AND LAKE COUNTIES)

The Reed City field was discovered, October 6, 1940, by the Weber Oil Company's Gabel No. 1, Sec. 31, T. 18 N., R. 10 W., which produced 29 barrels of oil from the Detroit River formation, after being acidized. The second well, ½ mile north, was completed in March, 1941, in the Dundee formation at 3,517 feet and produced 150 barrels of oil per day, after being acidized. The west offset of this well, The Pure Oil Company's Gingrich No. 1, did not produce from the Dundee but from the Detroit River formation at a depth of 3,643 feet. The well produced 1,900 barrels, natural flow, on May 5. The two earlier wells were then deepened a few feet to the new "pay." Development in the field thereafter was rapid. At the close of the year, 115 wells were producing and the daily average for the field in December was 18,610 barrels. The field at that time comprised about 3,000 acres.

The Reed City structure, in common with other Michigan structures, appears to trend northwest and southeast with steep dip on either flank. The regional dip is east-southeast. At the end of the year, nearly 60 feet of productive closure had been developed. Two pay zones are found in the Detroit River formation. The upper pay zone is found 20–25 feet below the top and averages 2½ feet in thickness. The second and most prolific "pay" is 30–40 feet below the top and averages about 2 feet in thickness.

During drilling operations, commercial wells were found in both the Traverse and Dundee formations, but usually were passed by for the bigger Detroit River production. Reed City field was the proving

TABLE III

DISCOVERY WELLS IN MICHIGAN DURING 1941

County	Field	Section-Township-Range	Operator	Well	Month and Day 1941	Feet Total Depth	Initial Production Oil (Barrels)	Initial Production Gas (1,000 Cubic Feet)	Formation	Remarks
				BASIN DISTRICT						
Calhoun	Albion	15- 3S - 4W	Continental Oil Co.	Turner 1	12-27	1,609		10,500	Traverse	720 pounds well-head pressure
Clare	Hatton	36-18N- 5W	Seba Oil	Oxendale 1	11-14	3,941	140 N[1]		Dundee	
Genesee	Otisville	5- 9N- 8E	H. H. Heinig	Dodge 1	8- 4	1,920	12 oil; 8 water		Traverse	
Isabella	Deerfield	20-14N- 5W	Burruss and Quinlan	Winesburg 1	3-18	1,292		22	"Michigan stray"	Later deepened to Dundee. Dry hole
Mason	Mason	9-17N-15W	Merrill and Dean	Young 1	6-21	3,303		135	Sylvania	
Osceola	Reed City	31-18N-10W	Pure Oil Company	Gingrich 1	5-29	3,643	1,900 N		Detroit River	1st well to big "pay"
Osceola	Evart	22-18N- 8W	Taggart Brothers Co.	Wirth 1	11-17	1,467		388	"Michigan stray"	
Osceola	Sylvan	7-18N- 7W	Turner Petroleum Co.	Gas Unit 1	8-15	1,528		1,920	"Michigan stray"	
Roscommon	Headquarters	34-21N- 3W	Eugene Hilliard	State A1	6-26	3,438	1,500 N (pinched)		Traverse	
Roscommon	Richfield	29-24N- 1W	Sun Oil Company	Bauman 1	12- 4	4,209	81 A[2]		Detroit River	
Tuscola	South Akron	28-14N- 8E	Smith Petroleum Co.	Partlo 1	11-16	2,869	50 A		Dundee	Possible extension
				SOUTHWESTERN MICHIGAN						
Allegan	West Hopkins	18- 3N-12W	Clifford Perry	Shafer 1	9-19	1,573	185		Traverse	
Allegan	Salem	21- 4N-13W	Regal Dutch Petroleum	Heasley 1	10-21	3,792		304	Salina	Deepened; well-head pressure, 1,150 pounds
Allegan	Lee	19- 1N-15W	Clapsaddle and Harris	Malstrom 1	10-31	1,171	150		Traverse	
Kent	Grandville	7- 6N-12W	Hogan Brothers	Zuidema 1	3-12	1,804	6		Traverse	
Van Buren	Muskrat Lake	1- 1S -14W	Fortney Oil Company	Pullin 1	6- 2	1,284	185		Traverse	

[1] N, natural flow.
[2] A, acidized.

ground for rotary drilling in Michigan. Previously a number of wells had been drilled with rotary equipment through the Marshall formation but were then completed with cable tools. In Reed City field, many wells were drilled to the 5-inch casing-point with rotary tools. A few wells were drilled with cable tools, but these were the exception. The glacial drift in the field varies from 600 to 700 feet in thickness.

A 6-inch pipeline was laid, connecting Reed City with existing lines in Temple field in Clare County. Two other lines were built to loading racks on the railroad in near-by Reed City.

HEADQUARTERS FIELD (ROSCOMMON AND CLARE COUNTIES)

Eugene Hilliard's State No. A1, Sec. 34, T. 18 N., R. 7 W., opened the Headquarters field on June 26 with a 1,500-barrel well in the Traverse limestone at 3,438 feet. This discovery is important since it represents the first major Traverse limestone field in the Basin district. Two pay zones are present. The upper is found within 10 feet of the top of the limestone and averages 2 feet in thickness. The lower and most prolific "pay" occurs approximately 100 feet below the top of the limestone and is 2–4 feet thick. At the end of the year, the field had been enlarged to 720 acres by eleven wells, and its average daily production was 3,338 barrels. A 6-inch line was laid 9 miles south to connect the field with an existing line.

KAWKAWLIN FIELD (BAY COUNTY)

The Kawkawlin field was expanded to approximately 2,000 acres by the 32 wells drilled during 1941. The field is on a large asymmetrical anticline on which the southwest flank is much steeper than the northeast. The structure apparently has 100 feet of closure on the Dundee formation. Two pay zones are present, The upper ranges from 5 to 20 feet thick and from 50 to 70 feet below the top of the Dundee. The lower zone averages 20 feet in thickness and ranges from 90 to 125 feet below the top of the formation. In the Dundee, porosity is generally not well developed and production falls rather rapidly after completion. Some wells produce profitably from the Berea sandstone and are not drilled deeper. In December, the field, with 37 producing wells, was averaging 1,141 barrels per day.

WINTERFIELD (CLARE COUNTY)

The Winterfield field was discovered late in 1940 by the Sun Oil Company's State-Winterfield No. A-1, Sec. 35, T. 20 N., R. 6 W., at 3,798 feet, producing 50 barrels per day and by Rowmor and Hughes' Wyman No. 1, Sec. 29, at 3,772 feet producing 359 barrels per day.

Both wells produce from the Dundee formation. The field is on the large central Michigan structure about 4 miles north of the Temple field. The chief producing formation is the Dundee although scattered wells produce commercially from the Traverse limestone. Development has not yet connected the pools although 27 wells were drilled during the year. The field in December was averaging 5,224 barrels per day. A 4-inch pipeline was constructed, connecting Winterfield with lines in Temple to the south.

SOUTHWESTERN MICHIGAN

The West Hopkins field, Allegan County, was discovered, September 19, 1941, by Clifford Perry's Shafer No. 1 in Sec. 18, T. 3 N., R. 12 W., in the Traverse limestone at 1,573 feet. The well made 185 barrels per day. The "pay" is in the upper 10 feet of the limestone. By the end of the year, 19 wells had been drilled and the field, covering about 500 acres, averaged 1,435 barrels per day.

The Muskrat Lake pool was discovered, June 2, 1941, by the Fortney Oil Company's Pullin No. 1, Sec. 1, T. 1 S., R. 14 W., Van Buren County. The well produced 185 barrels per day from the Traverse limestone at the depth of 1,284 feet. The pool is on a structural nose extending northward from the Bloomingdale structure toward the Trowbridge field in T. 1 N., R. 13 W., Allegan County. The "pay," which is thin and contains some water, is approximately 10 feet lower than the lowest wells in Bloomingdale. Forty-five wells were drilled this year. The field comprised 500 acres in December and averaged 674 barrels per day.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1110-1134, 3 FIGS.

DEVELOPMENTS IN APPALACHIAN AREA DURING 1941[1]

APPALACHIAN GEOLOGICAL SOCIETY[2]
Charleston, West Virginia

ABSTRACT

NEW YORK. In the Oriskany Sand area of southern New York, 41 wells were completed during 1941, 20 as gas wells with a combined open flow of 98,508,000 cubic feet, and 21 as dry holes, of which 8 can be considered as wildcat wells. No new producing areas were found during the year but the Howard area in Steuben County was developed from 1 well to a pool of 7 wells with a daily open flow of 6,929,000 cubic feet and 1 dry hole.

Production during the year from the Oriskany area continued to decline rapidly and the development of reserves by new drilling failed to equal depletion.

Eight wildcats were drilled during the year, all of which were unproductive. Three of these tests, located in Allegheny County, were drilled to the Oriskany and either found salt water, dry sand, or no sand present.

In Steuben County 4 tests were drilled, 3 of which encountered salt water in the Oriskany and the fourth was dry in the Medina sand.

One well located in Tompkins County encountered salt water in the Oriskany.

PENNSYLVANIA. More attention was focused on the further development of the shallow-sand gas territory of western Pennsylvania during 1941 than at any time during the past decade. The results were encouraging. Not only were some old pools extended but several new ones were discovered. Outstanding among these was the Armbrust pool in Westmoreland County, producing from the Fifth sand of the Upper Devonian. About 600 acres are included in the developed area and the limits of the pool have not been defined. A number of wells with open-flow capacities varying from 1,000 to 5 million cubic feet of gas per day were completed in the Big Injun sand of the Mississippian in western Fayette and eastern Greene counties. No exceptional developments occurred in the oil fields. Production was approximately 3.5 per cent less than during the previous year. Successful deep drilling operations were confined almost entirely to the Summit gas pool in Fayette County. A producing well, located about 3½ miles southwest of the southernmost of the earlier producers in the Summit pool, indicates that further exploration may extend considerably the productive area along the Chestnut Ridge anticline in that direction. Only five wells were completed in the Oriskany territory of north-central Pennsylvania, one of which was a small gas well and the others dry holes.

OHIO. Holes drilled in Ohio during 1941 numbered 1,561, of which 333 or 21 per cent produced oil, 701 or 45 per cent produced gas and 527 or 34 per cent were dry.

The total production was 3,547,534 barrels of oil produced from 24,801 wells. Exact figures on production and consumption of natural gas in Ohio are not available until late in the year. The hitherto unpublished figures for 1940 are 40,369 million cubic feet from approximately 7,000 active wells, and 129,856 million cubic feet consumed in the state during that year.

[1] Presented before the Association at Denver, April 22-24, 1942. Manuscript received, March 6, 1942.

[2] Contributing authors: "New York," John R. Reeves, Penn-York Natural Gas Corporation, Buffalo, New York, and Harvey J. Simmons, Jr., Godfrey L. Cabot, Inc., Charleston, West Virginia; "Pennsylvania," Charles R. Fettke, Carnegie Institute of Technology, Pittsburgh, Pennsylvania, and Parke A. Dickey, senior geologist, State of Pennsylvania, Pleasantville, Pennsylvania; "Ohio," J. R. Lockett, Ohio Fuel Gas Company, Columbus, Ohio; "West Virginia," J. E. Billingsley, West Virginia Gas Corporation, Charleston, West Virginia, and Robert C. Lafferty, The Owens, Libbey-Owens Gas Department, Charleston, West Virginia; "Kentucky," D. J. Jones, State geologist, Lexington, Kentucky, and Ralph N. Thomas, Inland Gas Corporation, Ashland, Kentucky; and "Tennessee," Kendall E. Born, Tennessee Division of Geology, Nashville, Tennessee.

The locations of nine important outlying deep dry holes, the completions in the state by counties and by sands, with the average initial production by sands, are given in tabular form.

WEST VIRGINIA. During the year 182 wells were drilled to or through the Oriskany sand in West Virginia. Of these, 166 were gas wells with a combined open flow of 764,568,000 cubic feet and 16 were dry.

The Elk-Poca and Sandyville Oriskany gas fields were extended to include 38 square miles of new territory. Eight of the 16 dry holes were drilled in defining the present boundaries of these fields. Two Oriskany wells, in the southeastern part of the Elk-Poca Oriskany field, were unsuccessfully deepened to the Clinton (Medina) sand.

An Oriskany test in Randolph County encountered salt water in the Oriskany. The Oriskany test in Roane County also encountered salt water.

The Oriskany test in Monongalia County encountered a showing of gas in the Huntersville chert but was dry in the Oriskany.

The Clinton test in Boone County was dry, as were the tests in Wood and Harrison counties. This latter test is the first deep rotary well in the state penetrating to a depth of 10,018 feet.

During the year the Department of Mines issued 1,087 drilling permits. Of this number, 495 were reported as gas wells, 48 as oil wells, 18 as combination oil and gas wells, 144 dry holes, 4 cancelled permits, and 369 unreported. During the year, 916 abandonment permits were issued, of which 472 were oil wells.

KENTUCKY (EASTERN). During the year, 422 wells were drilled. Sixty were dry; 259 were gas wells developing an open flow of 116,963,000 cubic feet per day; 103 were oil wells developing an initial production of 903 barrels of oil; and 6 pressure wells were completed.

Producing sands were found in formations ranging from the Salt sand (Pennsylvanian) down to the Sunnybrook (Ordovician).

Most of the drilling was in the eastern part of the state in developing Devonian shale gas production and extending existing pools. The Rockhouse pool developed in Johnson City from the Big Six (Silurian) sand was the only important new field.

TENNESSEE (EASTERN). During the year, 9 wells were completed in the area east of the Cincinnati arch, drilling a total of 13,705 feet. None of these wells can be classed as commercial although encouraging showings were found.

In the Cumberland Plateau area, several blocks of leases are still retained by a large company. In this area the pre-Mississippian remains essentially unexplored.

MARYLAND. One well was completed in the western Panhandle of Maryland. This well, located in the highly folded area of Garrett County, was completed at the total depth of 8,165 feet after encountering a showing of gas and salt water in the Oriskany sand at 8,096 feet.

VIRGINIA. Two wells were completed during the year, 1 in Wise County as a dry hole through the Devonian shale at the total depth of 5,348 feet, and 1 in Rockingham County encountering less than 100,000 cubic feet in the Devonian shale and Oriskany sand at the total depth of 2,986 feet.

ORISKANY PRODUCTION IN NEW YORK

During the year 1941, 41 wells were drilled in the Oriskany Sand area of southern New York, which includes Allegany, Steuben, Chemung, Schuyler, and Tompkins counties. Of these 41 wells, 20 were producers and 21 were dry holes.

The initial open flow developed during the year for all fields was 98,508,000 cubic feet, approximately 3 million cubic feet more than that developed in 1940.

Of the 41 wells drilled, 8 were wildcats, all of which were completed as dry holes.

During the year no new fields were discovered and, other than the 8 wildcats, all wells were drilled as extensions of old fields.

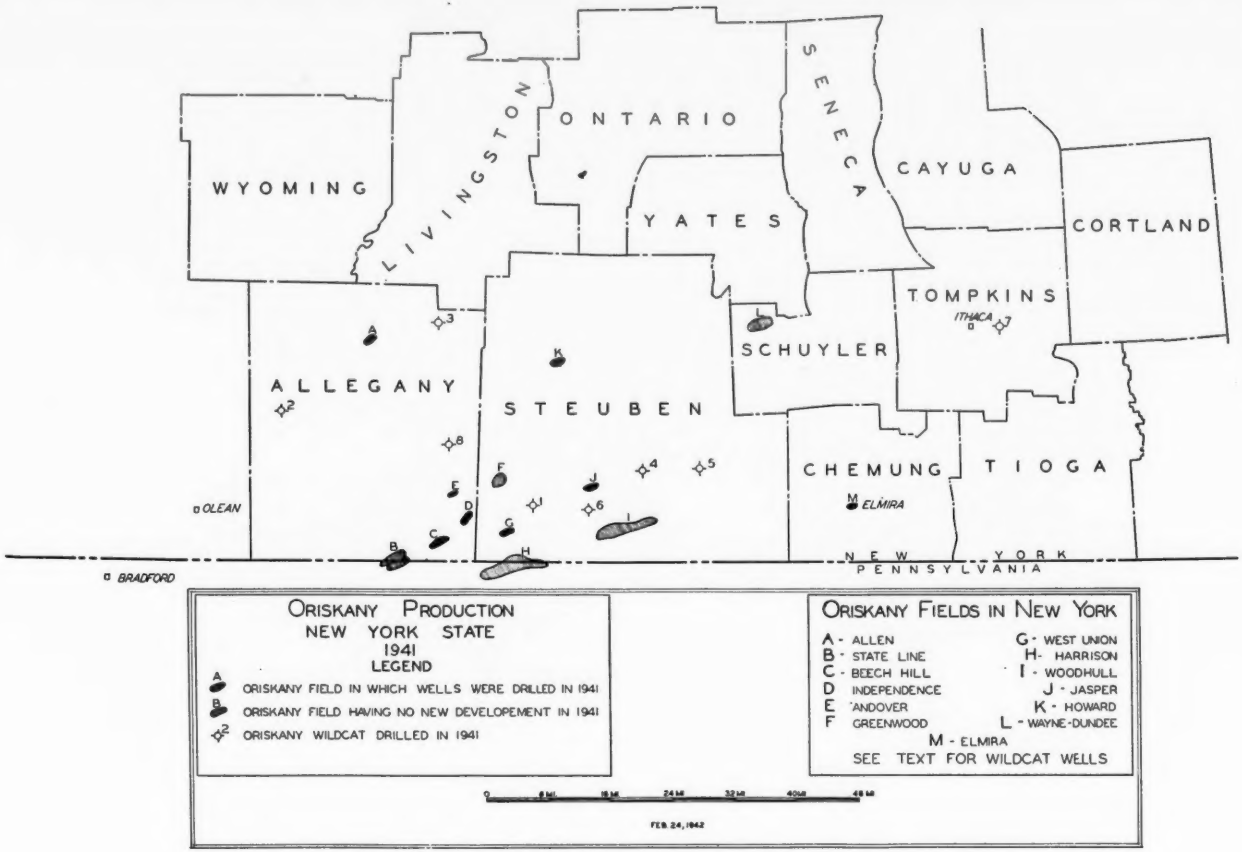

WYOMING
LIVINGSTON
ONTARIO
SENECA
CAYUGA
YATES
CORTLAND
TOMPKINS
ITHACA
SCHUYLER
ALLEGANY
STEUBEN
CHEMUNG
TIOGA
ELMIRA
OLEAN
BRADFORD
NEW YORK
PENNSYLVANIA
ORISKANY PRODUCTION
NEW YORK STATE
1941
LEGEND
ORISKANY FIELD IN WHICH WELLS WERE DRILLED IN 1941
ORISKANY FIELD HAVING NO NEW DEVELOPEMENT IN 1941
ORISKANY WILDCAT DRILLED IN 1941
ORISKANY FIELDS IN NEW YORK
A - ALLEN
B - STATE LINE
C - BEECH HILL
D INDEPENDENCE
E ANDOVER
F GREENWOOD
G - WEST UNION
H - HARRISON
I - WOODHULL
J - JASPER
K - HOWARD
L - WAYNE-DUNDEE
M - ELMIRA
SEE TEXT FOR WILDCAT WELLS
FEB. 24, 1942

FIG. 1

The following is a brief summary of the 1941 wells drilled, by fields.

In the Beech Hill field (*C*, Fig. 1), 2 wells were completed: one producing a total open flow of 250,000 cubic feet, and the other was a dry hole.

In the Independence field (*D*, Fig. 1), one dry hole and one producer were drilled with an open flow of 5,800,000 cubic feet.

In the Jasper field (*J*, Fig. 1), 6 wells were drilled, 5 of which were producers with a total open flow of 35,750,000 cubic feet. One was completed as a dry hole.

The largest open flow developed was in the West Union field (*G*, Fig. 1): a total open flow of 39 million cubic feet. Of a total of 5 wells drilled, only one was a dry hole.

Considerable activity was evidenced in the Howard field (*K*, Fig. 1) where 6 producers were completed. Their total open flow was 6,921,000 cubic feet. One dry hole was drilled.

Five wells were completed in the Allen pool (*A*, Fig. 1), 3 of which were dry holes and two were producers with a combined open flow of 10,500,000 cubic feet.

There was considerable activity in the Elmira pool (*M*, Fig. 1), located within the boundaries of the city of Elmira, with the completion of 7 wells. Five of the seven wells drilled were dry holes. The two producers had a total initial open flow of only 287,000 cubic feet.

The following is a summary of the wildcat wells drilled in the New York Oriskany area.

Van Gilder *et al.* F. Sherman No. 1 (No. 1, Fig. 1), in Jasper Township, Steuben County, was completed as a dry hole. A showing of gas was encountered in the Oriskany sand but was drowned out by salt water. The top of the Oriskany was at 4,827 feet. The elevation of the well is 2,236 feet.

Hill and McKinney's Harback No. 1, in New Hudson Township, Allegany County (No. 2, Fig. 1), found no Oriskany sand after drilling to a total depth of 3,389 feet. The Oriskany horizon was at 3,355 feet. The elevation of the well is 1,484 feet.

The Penn York's Dan Monagan No. 1 (No. 3, Fig. 1), in Birdsall Township, Allegany County, encountered the Oriskany sand at 2,840 feet. No oil, gas, or water was found. The elevation of this well is 1,538 feet.

The Belmont Quadrangle Drilling Company encountered salt water in the Oriskany sand in John McCraig No. 1, in Rathbone Township, Steuben County (No. 4, Fig. 1). The top of the Oriskany was encountered at 3,376 feet. The elevation of the well is 1,029 feet.

The deepest well drilled, stratigraphically, and in depth, was Godfrey L. Cabot's Ellen Collins No. 1 (No. 5, Fig. 1), in Erwin

FIG. 1

Township, Steuben County. The Oriskany sand was encountered at 3,802 feet, and the White Medina at 6,666 feet. The well was finished in the Queenston shale, at the total depth of 6,825 feet. The elevation of this well is 1,718 feet.

Another wildcat drilled by Godfrey L. Cabot, Inc., on the Bernard Hibbard farm (No. 6, Fig. 1), approximately midway between the Woodhull field and the Jasper field, in Woodhull Township, Steuben County, encountered salt water in the Oriskany sand. The top of the Oriskany was found at 4,254 feet. The elevation of the well is 1,452 feet.

Two other test wells, drilled by the Belmont Quadrangle Drilling Company, encountered salt water in the Oriskany sand. One was the George Hildreth No. 1 (No. 7, Fig. 1), in Dryden Township, Tompkins County, which encountered the top of the Oriskany sand at 1,905 feet. The elevation of the well is 1,213 feet. The other was the L. Lynch No. 1 (No. 8, Fig. 1), in Alfred Township, Allegany County. The top of the Oriskany was encountered at 4,414 feet. The elevation of the well is 2,208 feet.

Production for the past year from the Oriskany sand continued to decline rapidly and the addition of 1941 reserves failed to equal the depletion of the fields.

Following is a summary of 1941 Oriskany sand production by fields.

	1,000 Cubic Feet
Allen	153,821
State Line (North)	1,068,735
Woodhull	606,577
Beech Hill (Independence)	778,409
Jasper	660,021
West Union	2,126,591
Greenwood	149,228
Elmira	100,000
Total 1941 production	5,644,382

PENNSYLVANIA[3]

INTRODUCTION

More attention was focused upon the further development of the shallow-sand gas territory of western Pennsylvania during 1941 than at any time during the past decade. The results were encouraging. Not only were some old pools extended but several new ones were discovered. No unusual developments occurred in the oil fields. Production was approximately 3.5 per cent less than during the previous

[3] Published by permission of the State geologist of Pennsylvania. The writers acknowledge the assistance of F. H. Finn, John T. Galey, and D. T. Secor, who contributed part of the data.

year. Successful deep-drilling operations were confined almost entirely to the Summit gas pool in Fayette County.

SHALLOW-SAND DEVELOPMENTS

GAS

Southwestern Pennsylvania.—Shallow-well completions in southwestern Pennsylvania during 1941 are shown in Table I. The 440 new gas wells had a total initial open-flow capacity of 173,600,000 cubic

TABLE I

SHALLOW-WELL COMPLETIONS IN SOUTHWESTERN PENNSYLVANIA, 1941

County	Completions	Gas		Oil			Average Feet Total Depth (All Wells)
		Number of Wells	Average Initial Open-Flow Capacity (1,000 Cubic Feet Per Day)	Number of Wells	Average Initial Production (Barrels Per Day)	Dry	
Allegheny	16	11	1,309	1	5	4	2,450
Armstrong	110	103	152	0		7	2,970
Beaver	3	1	50	0		2	
Butler	60	7	430	36	2.1	17	1,790
Fayette	60	45	824	0		15	2,010
Greene	91	74	675	5	27.4	12	2,770
Indiana	22	11	55	0		11	3,260
Lawrence	5	3	50	0		2	
Washington	64	48	327	5	15.8	11	2,360
Westmoreland	139	137	248	0		2	2,500

feet of gas per day. Outstanding among the new developments was the Armbrust pool in Hempfield Township, Westmoreland County, producing from the Fifth sand of the Upper Devonian. At the end of February, 1942, 35 wells had been completed and 20 were drilling. About 600 acres are included in the productive area and the limits of the pool have not been defined. Depth of sand ranges from 1,900 to 2,200 feet. The wells have an average initial open-flow capacity of 780,000 cubic feet per day, individual wells ranging from 40,000 cubic feet to 4,000 million. Reservoir pressure at the end of the year was 1,015 pounds per square inch.

Several wells with initial open-flow capacities varying from 1,000 to 5 million cubic feet of gas per day were completed in the Big Injun sand of the Mississippian in western Fayette and eastern Greene counties. A well in Forward Township, Allegheny County, had an initial open-flow capacity of 9 million cubic feet per day from the Bayard sand of the Upper Devonian.

Northern and central districts.—A summary of activities in the shallow gas-sand territory of the northern and central districts during 1941 is given in Table II. The 371 new gas wells had a total initial open-flow capacity of 52,390,000 cubic feet of gas per day. Renewed interest in the commercial possibilities of "shale gas" in the Portage group of the Upper Devonian resulted in the drilling of successful wells in the northwest corner of Erie County. The wells average about 650 feet in depth.

TABLE II

SHALLOW-WELL COMPLETIONS IN GAS FIELDS OF NORTHERN AND CENTRAL PENNSYLVANIA, 1941

County	*Completions*	*Gas*		*Dry*	*Average Feet Total Depth (All Wells)*
		Number of Wells	*Average Initial Open-Flow Capacity (1,000 Cubic Feet Per Day)*		
Clarion	116	110	69	6	2,291
Clearfield	9	6	59	3	3,227
Crawford	1	0		1	800
Erie	16	15	914	1	671
Elk	42	36	175	6	2,424
Forest	13	12	129	1	2,306
Jefferson	134	121	157	13	2,792
McKean	42	38	62	4	2,291
Warren	6	6	72	0	1,282
Venango	29	27	41	2	1,846

OIL

Drilling for oil in areas outside those in which secondary-recovery operations are under way was at a very low ebb during 1941. Production was approximately 3.5 per cent less than during the previous year. In the Bradford field, 3,207 new wells were drilled, about half of which were water in-take wells. The field accounted for 52.3 per cent of the total Pennsylvania grade crude-oil production in 1941. Two hundred two wells were completed in the Kane-Clarendon area where water-flooding operations are also under way.

Air- and gas-repressuring projects continued at an accelerated rate in the Titusville-Oil City district during the first 6 months of the year. On account of the small margin of profit under which these projects are operated, the imposition of a price ceiling on August 22 resulted in a notable curtailment of activity.

Average daily production from the Music Mountain pool, Lafayette Township, McKean County, had dropped from a peak of about 7,000 barrels early in 1940 to 1,600 barrels of oil at the end of 1941. The pool had produced 3,280,000 barrels of oil from 670 acres

TABLE III

WELLS COMPLETED AND DRILLING IN SUMMIT POOL, FAYETTE COUNTY, PENNSYLVANIA DURING 1941

(Depths to formations are shown in feet)

Map No.	Township	Well	Company	Feet Elev.	Tully	Top of Onondaga Limestone	Top of Cherl	Oriskany	Total Depth	Month, Day, Year Completed	Results[1]
1	South Union	Piedmont Coal Co. 3	Peoples Natural Gas Co.	2,405	6,048–6,138	6,755	6,801	7,090–7,243	7,272	3-12-1941	Gas at 6,815–6,861; 7,146; most at 7,249–7,257. 2,800 M. cu. ft. I.O.F., 2,200 lb. R.P.
2	South Union	Piedmont Coal Co. 5	Peoples Natural Gas Co.	2,460	5,977–	6,540	6,576	6,744–6,836	7,080	11-15-1941	Gas at 6,604–6,607; 6,615–6,662; 6,740–6,748; 6,812. 1,012 M. cu. ft. I.O.F., 1,800 lb. R.P.
3	South Union	Leo F. Heyn 3	Wm. E. Snee and New Penn. Dev. Corp.	2,314	5,845–5,915	6,365–	6,395	6,579–	6,792	5-13-1941	Gas at 6,420–6,439; 6,443. 2,125 M. cu. ft. I.O.F., 2,095 lb. R.P.
4	Wharton	Leo F. Heyn 4	Wm. E. Snee and New Penn. Dev. Corp.	2,531	6,005–6,100	6,480	6,505		6,528	2- 3-1942	Gas at 6,519; 6,528. 5,520 M. cu. ft. I.O.F.
5	North Union	Mrs. J. H. Sorg 2	W. W. Wasson *et al.*	2,511	6,351–	6,984	7,068	7,282–	7,365	9- 2-1941	Gas at 7,143; 7,352. 2,000 M. cu. ft. I.O.F.
6	Georges	Barton Estate 1	Greensboro Gas Co.	2,324	6,442–	7,142–	7,158		7,272	12-30-1941	Gas at 7,147–7,237. 1,500 M. cu. ft. I.O.F., 3,275 lb. R.P.
		WELLS DEEPENED									
7	North Union	Mrs. J. H. Sorg 1	W. W. Wasson *et al.*	2,580	6,401–	6,925		7,109	7,184	10-28-1941	Deepened, 7,119 to 7,184. No additional gas
8	South Union	Piedmont Coal Co. 1	Peoples Natural Gas Co.	2,369	5,919–	6,510–		6,709–	6,849	2- 3-1942	Deepened, 6,825 to 6,849. 10,100 M. cu. ft. I.O.F.
		WELLS DRILLING									
9	South Union	Piedmont Coal Co. 4	Peoples Natural Gas Co.	2,491	6,756–6,909	8,089	8,115				Drilling
10	Wharton	O. J. Kirby 1	Wm. E. Snee and New Penn. Dev. Corp.	2,690	6,985–						Drilling at 7,038
11	South Union	Carothers Estate 1	Wm. E. Snee and New Penn. Dev. Corp.	2,567							Drilling at 7,092

[1] Depth of gas shown in feet.
M. cu. ft. I.O.F.—thousand cubic feet, initial open-flow production.
lb. R.P.—pounds rock pressure.

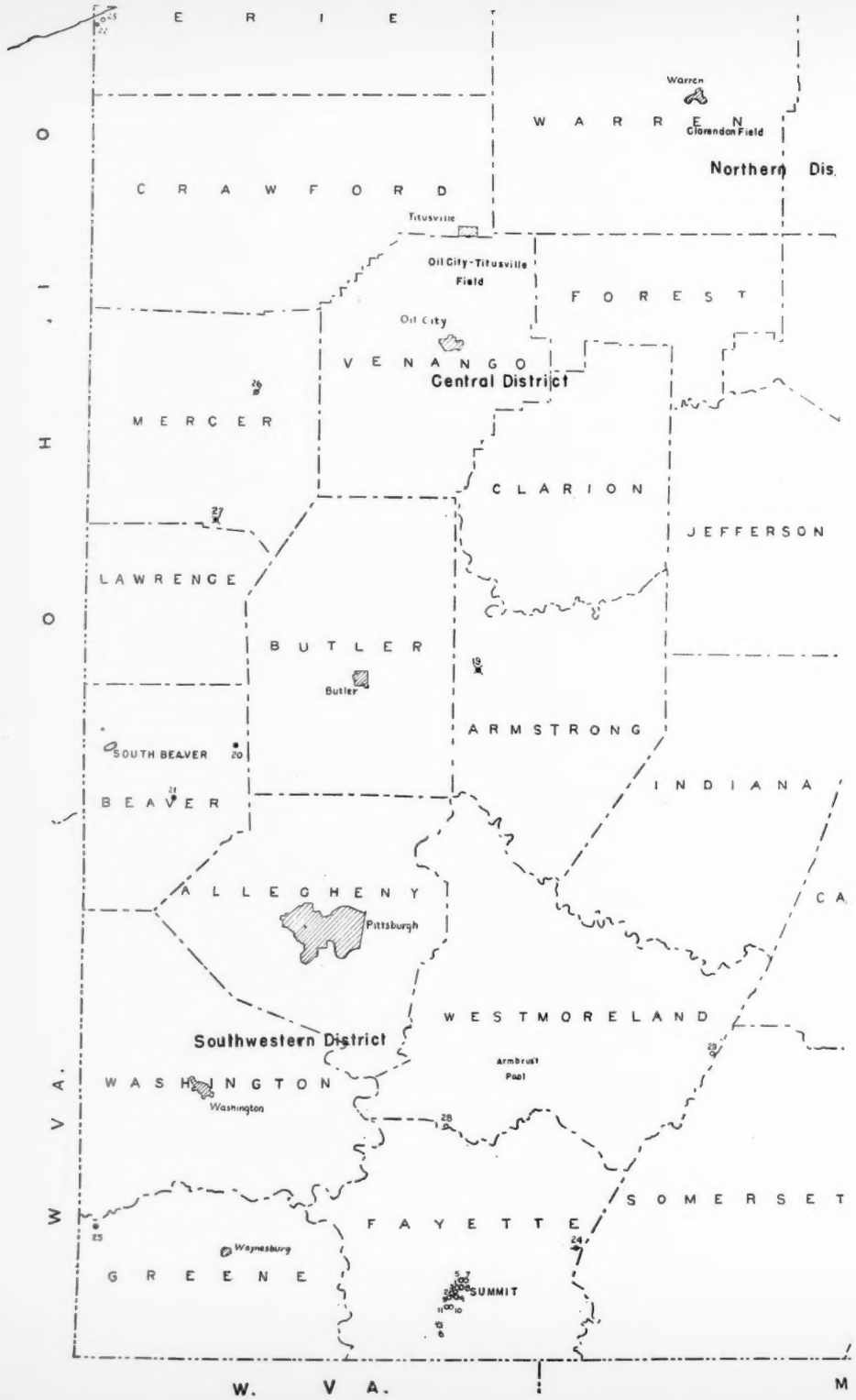
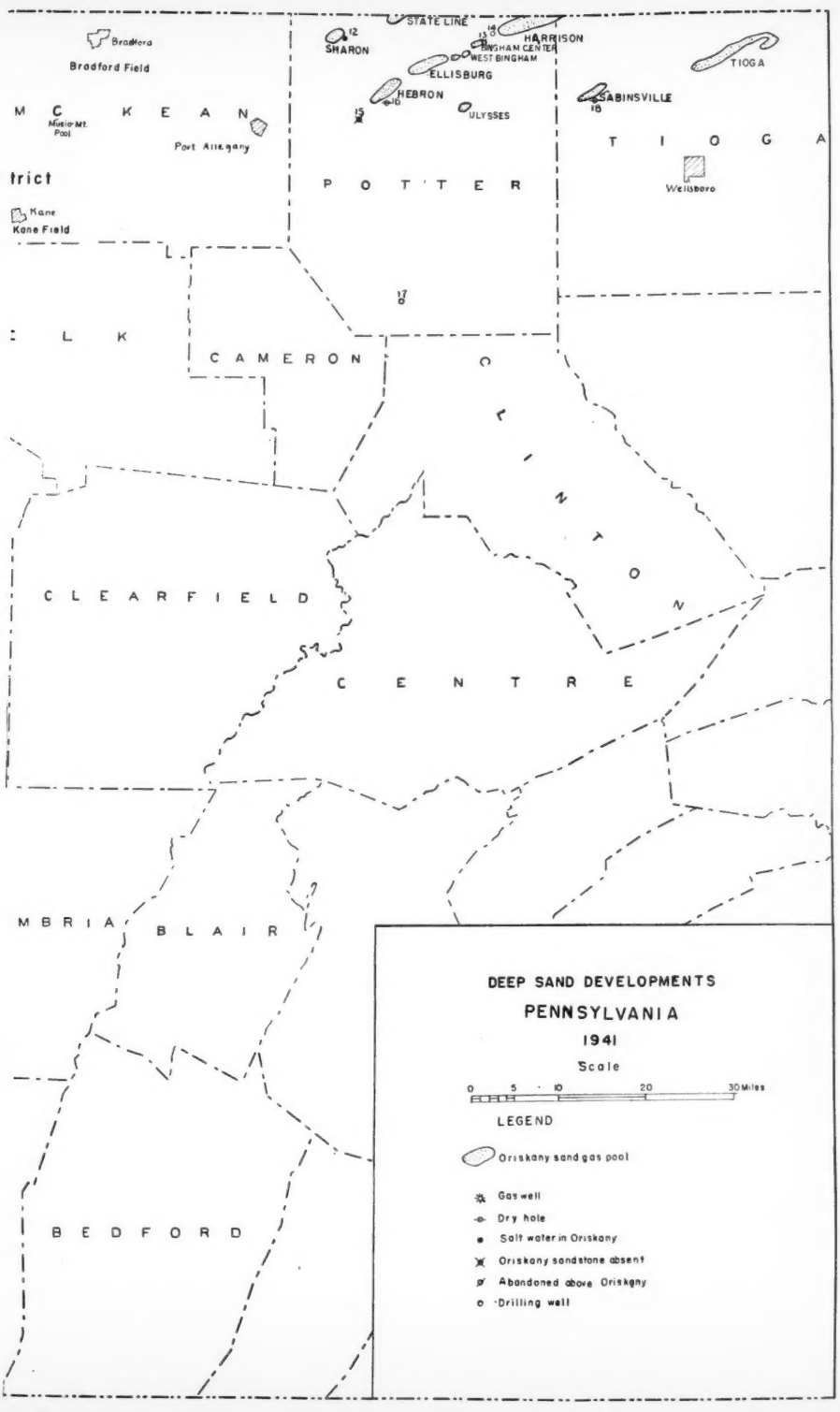

E R I E
Warren
W A R R E N
Clarendon Field
Northern Dis.
C R A W F O R D
Titusville
Oil City-Titusville Field
F O R E S T
Oil City
V E N A N G O
Central District
M E R C E R
C L A R I O N
J E F F E R S O N
L A W R E N C E
B U T L E R
Butler
A R M S T R O N G
SOUTH BEAVER
B E A V E R
I N D I A N A
A L L E G H E N Y
Pittsburgh
W E S T M O R E L A N D
Southwestern District
Armbrust Pool
W A S H I N G T O N
Washington
S O M E R S E T
F A Y E T T E
Waynesburg
G R E E N E
SUMMIT
O H I O
W. V A.
W. V A.

FIG. 2


N. Y.
STATE LINE
SHARON
HARRISON
BINGHAM CENTER
WEST BINGHAM
ELLISBURG
HEBRON
ULYSSES
SABINSVILLE
TIOGA
Bradford
Bradford Field
M C K E A N
Main Mt. Pool
Port Allegany
trict
Kane
Kane Field
P O T T E R
T I O G A
Wellsboro
L
: L K
CAMERON
O
N
E
I
D
A
CLEARFIELD
C E N T R E
MBRIA
B L A I R
B E D F O R D
DEEP SAND DEVELOPMENTS
PENNSYLVANIA
1941
Scale
0 5 10 20 30 Miles
LEGEND
Oriskany sand gas pool
Gas well
Dry hole
Salt water in Oriskany
Oriskany sandstone absent
Abandoned above Oriskany
Drilling well
D.

at the end of 1941. Attempts made during 1941 to find an extension of production along the Music Mountain trend southwest were unsuccessful.

DEEP-SAND DEVELOPMENTS

SUMMIT GAS POOL, FAYETTE COUNTY

Active development of the Summit gas pool, opened in 1936, is continuing. Six producing wells were completed during 1941 and the early part of 1942 and three wells are drilling. The new work is summarized in Table III. One of the six wells, $3\frac{1}{2}$ miles southwest of the southernmost of the earlier producers, indicates that further exploration may extend considerably the productive area along the Chestnut Ridge anticline in that direction. The well had an initial open-flow capacity of 1,500,000 cubic feet of gas per day in the upper part of the Onondaga chert. The reservoir pressure was 3,275 pounds per square inch at this locality, or about 200 pounds higher than the highest pressure observed in the exploited part of the Summit pool at the time of discovery.

ORISKANY GAS FIELDS OF NORTH-CENTRAL PENNSYLVANIA

Five wells were completed in the Oriskany gas fields of north-central Pennsylvania during 1941 as shown in Table IV. Only one of these was a small producer, located at the northeast end of the Bingham Center pool in Bingham Township, Potter County. Another, located at the eastern margin of the Sharon pool in Oswayo Township, Potter County, encountered salt water in the Oriskany sand. The remaining three tests represent unsuccessful attempts to locate detached fault blocks with sufficient closure to be productive south of the Hebron and Sabinsville pools in Potter and Tioga counties, respectively.

OTHER DEEP TESTS

The results of deep drilling during 1941 in western Pennsylvania outside the producing areas are summarized in Table V. A deep test on the Laurel Hill anticline in Stewart Township, Fayette County, after having passed through the Oriskany sandstone and encountering only 16,000 cubic feet of gas, was stopped at 8,498 feet. This, at present, is the deepest well in Pennsylvania. In northwestern Erie County, a St. Peter test was abandoned early in the year, after encountering a showing of oil and gas and considerable salt water in this formation. Another test is under way in this area, about a mile northeast of the first one. The Oriskany sandstone was absent in a test in Armstrong County and in one in Mercer County. The latter appreciably extended toward the west the area in which the Oriskany sandstone is absent.

TABLE IV

ORISKANY SAND WELLS COMPLETED AND DRILLING IN NORTH-CENTRAL PENNSYLVANIA DURING 1941
(Depths to formations are shown in feet)

Map No.	Township	Well	Company	Feet Elev.	Tully	Onondaga	Oriskany	Total Depth	Month, Day, Year Completed	Results
POTTER COUNTY										
12	Oswayo	Bert Dunshie 1	Empire Gas & Fuel Co.	2,061	4,439–4,485	4,975–5,021	5,021–	5,028	8-12-1941	280 M. cu. ft. gas. 720 lb. R.P. 800 ft. salt water; abd.
13	Bingham	Carpenter-Young 1	Hanley & Bird	2,112	4,554–4,602	5,190–5,226	5,226–	5,237	11- 8-1941	769 M. cu. ft. gas. 500 lb. R.P.
14	Bingham	Clayton Webster 1	Hanley & Bird							Drilling
15	Hebron	C. W. Gorham Estate 1	Allegany Gas Co.	2,214	5,109–5,161	5,691–	No sand	5,810	10-21-1941	No sand at Oriskany horizon
16	Hebron	Wm. B. Hemphill 1	Godfrey L. Cabot, Inc.	2,093	4,787–4,841	5,393–5,415	5,415	5,433	11-19-1941	A little salt water; Abandoned
17	Wharton	Central Penn. Lumber Co. 2	Godfrey L. Cabot, Inc.							Drilling
TIOGA COUNTY										
18	Clymer	Wallace Ackley	Allegany Gas Co.	1,828	4,653–4,715	5,463–5,486	5,486–5,502	5,544	11-15-1941	Dry

TABLE V

DEEP TESTS COMPLETED AND DRILLING IN WESTERN PENNSYLVANIA DURING 1941

(Depths to formations are shown in feet)

Map No.	*County*	*Township*	*Well*	*Company*	*Feet Elev.*	*Tully*	*Onondaga*	*Oriskany*	*Medina*	*Top of Trenton*	*Top of St. Peter*	*Total Depth*	*Month, Day, Year Completed*	*Results*
19	Armstrong	West Franklin	W. T. Beidenbach	T. W. Phillips Gas & Oil Co. and John T. Galey	1,170	5,416–	5,773–5,907	No sand				6,000	9-29-1941	Dry. No sand at Oriskany horizon
20	Beaver	New Sewickley	Elmer Pflug 1	C. D. McMichael *et al.*	1,153		5,282–5,437	5,437–				5,449	7-15-1941	3 M. cu. ft. gas, 5,437–5,445. Salt water, 5,445
21	Beaver	Center	J. P. Koehler Estate	St. Joseph Lead Co.	1,166		5,145–5,312	5,312–				5,345	2-12-1942	½ bbl. s.w. per hour, 5,319–5,330
22	Erie	Springfield	Jay Childs 1	Ohio Oil Co.	635		1,377–1,663	1,663–1,695	2,624–2,793	4,437	5,179	5,191	3-29-1941	1,370 ft. s.w. in Oriskany 7 M. cu. ft. gas and show oil, top of Trenton; small show oil and gas, top St. Peter, 2,000 ft. s.w. in St. Peter
23	Erie	Springfield	N. Blickensderfer 1	Ohio Oil Co.									Drilling	
24	Fayette	Stewart	Gregg L. Neel 1	Wm. E. Snee & New Penn. Dev. Corp.	2,568		8,049–	8,298–				8,498		16 M. cu. ft. gas at 8,493. Abandoned
25	Greene	Richhill	S. G. Alley 1	Manufacturers Light & Heat Co.	1,246		6,776–	7,016				7,040	2-27-1942	1½ barrels s.w. per hour at 7,034
26	Mercer	Lake	J. Paul Miller 1	Beal and McCandless								2,115		Did not reach Onondaga
27	Mercer	Springfield	S. H. Collins 12	E. A. Bream Co.	1,289		4,280–4,424	No sand				4,467		Dry. No sand at Oriskany horizon
28	Westmoreland	South Huntingdon	Jacobs Creek Oil Co. 1	Peoples Natural Gas Co.	964	6,720–6,736	7,317–						Drilling	7,534 in Onondaga chert
29	Westmoreland	Ligonier	John Beck 1	Wm. E. Snee & New Penn. Dev. Corp.	2,784								Drilling	

GEOPHYSICAL EXPLORATION

The Texas Company stopped its seismic prospecting in southwestern Pennsylvania during the summer of 1941 after having covered most of Lawrence, Butler, and Beaver counties and parts of Allegheny, Washington, and Greene. Some exploration based on geochemical studies was carried out by several operators in the northern district. The results of this work have not been made public. A party of the Geophysical Section of the United States Geological Survey spent 6 weeks near Titusville, testing a direct-current resistivity method of locating stratigraphic type oil accumulation. This work was sponsored and partly supported by the Pennsylvania Topographic and Geologic Survey. The results were encouraging, but no definite conclusions have been reached as yet.

Much interest in the technique of electric logging of wells was manifested by certain operators. A committee was appointed to invite proposals from service companies engaged in this activity and it is hoped that this very important geological technique may be made available to the operators early in 1942. With the general realization that most of the shallow sand oil and gas pools of western Pennsylvania are dependent on some type of stratigraphic control, increased emphasis is being placed upon stratigraphic studies as a means of discovering additional reserves.

OHIO[4]

DRILLING ACTIVITY

Drilling activity in Ohio was greatly increased during 1941. The total of 1,561 completions was 27 per cent more than for the year 1940 and considerably more than were drilled during any year of the depression. Of these 333 or 21 per cent produced oil, 701 or 45 per cent produced gas and 527 or 34 per cent were dry.

OIL PRODUCTION

The total oil production for the year was 3,547,534 barrels from 24,801 wells. For 1940 it was 3,052,000 barrels from 25,500 wells. This increase of approximately 500,000 barrels, which was practically all of Pennsylvania grade, was chiefly due to an extension of the Clinton sand oil field in Clayton Township, Perry County, where a number of flowing wells were completed. Initial 24-hour production of these wells ranged from 333 to 575 barrels.

[4] The writer appreciates the collaboration of the members of the geological department and the gas depletion department of The Ohio Fuel Gas Company, K. C. Cottingham, chief geologist.

GAS PRODUCTION

Preliminary figures for gas production and consumption in the state during the year are not available yet. The production for 1940 (as yet unpublished) was 40,369 million cubic feet from approximately 7,000 wells. This was approximately half the maximum for the state produced during 1915. The gas consumed in Ohio during 1940 was 129,856 million cubic feet or 77 per cent of the maximum during the year 1916. Present indications are that the figures for both gas produced and consumed during 1941 will be slightly higher than those for 1940.

Five Clinton gas wells, with initial open-flow capacities ranging from 10 million to 12 million cubic feet were completed in Muskingum and Morgan counties.

Extensions to Clinton fields were opened in Stark, Medina, Wayne, Muskingum, Morgan, and Perry counties, but the additional area developed does not alter the outlines of those fields sufficiently to warrant the publication of a special map.

The first production from the Clinton sand in Harrison County was obtained in Washington Township, where one well at the total depth of 5,899 feet had an initial open flow of 471,000 cubic feet and a rock pressure of 1,380 pounds. Another in Section 32, at 5,820 feet depth, had an open flow of 365,000 cubic feet and a rock pressure of 1,220 pounds. Four other Clinton tests in the immediate vicinity, the deepest of which reached 6,255 feet, were totally dry.

IMPORTANT DRY HOLES

Nine important dry holes were drilled in outlying areas where the deeper formations penetrated had not been previously tested. The locations and depths of these are given in the following Table VI.

TABLE VI

OUTLYING DEEP DRY HOLES

County	*Township*	*Section*	*Farm and No.*		*Total Depth in Feet*	*Formation Reached*
Belmont	Smith	19	Mobley	7	7,887	Medina
Wayne	Wooster	14	Armstrong	8	6,116	Lower Magnesian
Geauga	Chardon	1	Crile	1	6,101	"St. Peter"
Knox	Howard	8	Perkins	1	4,945	"St. Peter"
Carroll	Monroe	9	Tipton	1	5,496	Medina
Mahoning	Smith	4	Schrum	1	5,020	Medina
Noble	Elk	21	Ullman	9	4,728	Oriskany
Washington	Warren	29	Ammon	1	4,651	Oriskany
Morgan	Marion	23	Newton	14	4,530	Medina

SECONDARY RECOVERY

During the year, 129 Berea oil wells and 105 water-injection wells were drilled in a flooding project in Lodi Township, Medina County

TABLE VII

COMPLETIONS IN OHIO IN 1941 BY COUNTIES

(Old wells drilled deeper during year are not included)

County	*Oil Wells*	*Gas Wells*	*Dry Holes*	*Total*
Allen	2		2	4
Ashland	10	20	36	66
Ashtabula		1	2	3
Athens	12	60	43	115
Auglaize			1	1
Belmont		2	7	9
Carroll			3	3
Columbiana	2	4	15	21
Coshocton	8	10	8	26
Cuyahoga		21	7	28
Fairfield		11	3	14
Gallia		9	1	10
Geauga			1	1
Guernsey		10	16	26
Hancock	1			1
Hardin	1		1	2
Harrison		2	8	10
Henry			2	2
Hocking	2	6	6	14
Holmes	1	12	7	20
Jackson			1	1
Jefferson	6	2	8	16
Knox	4	43	30	77
Lawrence		20	2	22
Licking	26	102	46	174
Lorain	1	10	19	30
Lucas			2	2
Mahoning	1	2	3	6
Medina*	129	23	47	199
Meigs	2	63	28	93
Mercer	1			1
Monroe	7	31	11	49
Morgan	2	29	19	50
Muskingum	5	45	17	67
Noble	18	34	30	82
Ottawa		1		1
Perry	58	10	11	79
Portage			2	2
Putnam	2			2
Richland		1	1	2
Seneca		1	6	7
Stark		20	5	25
Summit		8	3	11
Tuscarawas		21	10	31
Van Wert			2	2
Vinton		1	3	4
Washington	30	46	32	108
Wayne		20	13	33
Williams			1	1
Wood	2		1	3
Wyandot			5	5
Total	333	701	527	1,561

* Approximately 105 Berea holes, drilled as water-injection wells, are not included.

where the Berea lies at an average depth of 475 feet. The results during this second year of development were very encouraging, but exact figures on recovery are not yet available as the oil, which is of Lodi grade, was reported with Cleveland grade after September 1.

All completions in the state are given by counties in Table VII. The completions with the average initial production of oil and gas are summarized by sands in Table VIII.

TABLE VIII

WELLS COMPLETED IN OHIO IN 1941, BY SANDS, WITH AVERAGE INITIAL PRODUCTION

Sand	*Oil Wells*	*Average Initial Daily Prod. Per Well (Barrels)*	*Gas Wells*	*Average Initial Daily Prod. Per Well (1,000 Cubic Feet)*	*Dry Holes*	*Total*
Shallow	65	4	162	381	123	350
Berea	178	6	150	188	150	478
Ohio shale	0	—	26	191	15	41
Oriskany	0	—	7	432	4	11
Newburg	1	36	29	1,356	2	32
Clinton	80	111	325	1,092	206	611
Trenton	9	5	2	50	20	31
Sub-Trenton	0	—	0	—	7	7
Total wells and average production	333	31	701	702	527	1,561

WEST VIRGINIA

During 1941 there were 182 wells drilled to or through the Oriskany sand in West Virginia. Of these, 166 were gas wells with a combined open flow of 764,568,000 cubic feet, and 16 were dry.

At the present development of the Oriskany gas fields in Kanawha and Jackson counties, it is desirable for convenience in writing to divide the gas-productive areas into three fields.

The Elk-Poca field is considered as that productive area beginning near the Elk River and the city of Charleston and extending northward to the north boundary of the Kenna Quadrangle.

The Sandyville field is considered as that productive area joining with the Elk-Poca on the south and extending north from this junction to the Jackson-Wood County line, about 15 miles north of the village of Ripley.

The Campbells Creek field is considered as that productive area beginning 5 miles southeast of the city of Charleston, beginning near the Campbells Creek and continuing in a southern direction a few miles south of the Kanawha-Boone County line. Production by fields is shown on p. 1128.

Approximately 38 square miles of new territory were developed by these wells in extensions of the three fields.

Only one producing Oriskany gas well was drilled outside of the limits of the fields. This wildcat discovery, located near the crest of the Chestnut Ridge anticline in Freeman's Creek district, Lewis County, encountered approximately 500,000 cubic feet of gas, after being shot, from the Oriskany sandstone. Indications are that the rock pressure will be in excess of 2,000 pounds as this well was completed at the total depth of 7,325 feet. This was a rotary test and is being blown at regular intervals to clean the mud fluid and water from the sand.

Of the 16 dry holes completed, 5 were located in Jackson County, 4 in Kanawha County, 2 in Boone County, and 1 in Putnam County, and most of these can be considered as being drilled to define the present boundaries of the three fields.

The wildcat test in Randolph County, located on a prominent anticline near the Appalachian structural front, encountered salt water in the Oriskany and was completed at the total depth of 1,816 feet, 66 feet below the base of the sand.

The wildcat test in Roane County, just north of the Roane-Kanawha line, encountered water in the Oriskany.

In Monongalia County the test, located near the crest of the Chestnut Ridge anticline, encountered 33,000 cubic feet of gas in the Huntersville chert but the test was dry in the underlying Oriskany, and the well was abandoned at the total depth of 7,684 feet.

During the year, 5 tests were completed to or through the Clinton (Medina) sand: 2 in Kanawha County, 1 in Boone County, 1 in Harrison County, and 1 in Wood County. These tests bring the total Clinton or deeper tests in the state to 20, of which number 2 located near the crest of the Warfield anticline are small gas wells in the Newburg, Big Six, and Clinton sands. While the ratio of producers to dry holes is not encouraging, in all fairness it should be kept in mind that most Clinton tests are such because they were dry in upper formations, and probably not more than 5 of the total tests were located with definite ideas of testing the Clinton or deeper sands, and presumably on structure.

One of the two tests located in Kanawha County on the southeast side of the Elk-Poca field encountered 68,000 cubic feet of gas after being shot in the Clinton sand, while the other was not completed, due to loss of the hole before the sand was completely penetrated. The test in Boone County encountered non-commercial amounts of gas in the Oriskany, Newburg, and Clinton sands, but was a small com-

mercial gas well in a shallow sand. The test in Wood County encountered a completely barren sand. The test in Harrison County was West Virginia's first rotary test and was drilled to the total depth of 10,018 feet, encountering a showing of gas in the Oriskany, but was dry through the Clinton.

The Elk-Poca field and the Sandyville field roughly represented by an axe-shaped outline, with the handle or Sandyville portion on the north and the Elk-Poca field on the south representing the major area, are rapidly having their limits defined, with a thinning sand and low porosity pinch-out toward the west and a salt water rim toward the east. Successful wildcatting north of the Sandyville area will probably be restricted to a rather narrow area with hazards of low porosity on the west and salt water on the east. On the north in the direction of Parkersburg, a considerable area yet remains untested as does the area west of the dry holes south of this city. Southward the picture is not especially encouraging.

Contemplated deep wildcatting at the end of the year is seen in a test located in the western part of Tyler County, which seems definitely under way, and the possibility of at least two other tests in this general area.

During the year, 1,087 drilling permits for new wells were issued by the West Virginia Department of Mines. Of this number, 495 were reported as gas wells, 48 as oil wells, with a reported total of 777½ barrels per day, 18 combination oil and gas wells, 144 dry holes, 4 cancelled drilling permits, and 369 unreported. During the year, 916 abandonment permits were issued, of which amount 472 were oil wells.

WEST VIRGINIA ORISKANY GAS FIELDS DATA
(Production in 1,000 cubic feet)

Field Name	*Gas Wells Completed*	*Open Flow Developed*	*Average Open Flow Per Well*	*Range of Open Flow*	*Located and Drilling Wells**
Elk-Poca	127	537,263	4,230	17,436 to 103	68
Sandyville	37	226,647	6,126	18,151 to 189	39
Campbells Creek	1	158	158		1
Total 1941	165	764,068			108
Elk-Poca	543	3,390,052			
Sandyville	45	235,230			
Campbells Creek	46	71,793			
Total (since discovery)	634	3,697,075			

* There will be some adjustment in these figures due to recently proposed Government regulations concerning drilling in the Appalachian area.

KENTUCKY (EASTERN)

During the year, 422 wells were completed in eastern Kentucky. Of these, 259 were reported as gas wells with a combined open flow of 116,963,000 cubic feet, 103 as oil wells with an initial production of 903 barrels per day. Six of these latter wells are pressure wells.

Sixty dry holes, testing formations ranging from the Salt sands (Pennsylvanian) to the Knox (Cambro-Ordovician) were completed.

During the year there were 6 widely scattered deep tests drilled in eastern and central Kentucky. Four of these, located in Clark, Elliott, Laurel, and Magoffin counties, were drilled into the upper Knox dolomite. The other two, located in Knott and Martin counties, reached the stratigraphic position of the "Clinton" sand. None of these wells produced oil or gas in commercial quantities. This, on its face value, is discouraging. However, from a geological standpoint the information revealed by these wells is rather encouraging.

	Depths in Feet
CLARK COUNTY	
W. O. Allen *et al.* Chism Farm	
Garrard and Million	105
Cynthiana	255
Trenton (Top Tyrone zone)	375– 618
High Bridge	618–1,230
Everton sand	1,230–1,265
Knox	1,285
Total depth	2,020
ELLIOTT COUNTY	
Inland Gas Corp.	
J. H. Fraley No. 1	
Elevation: 796 feet	
Corniferous	1,398–1,775
Shale (Brassfield position)	2,012
Maysville and Trenton	2,114–3,143
Tyrone	3,143
Joachim	3,766–3,910
St. Peter(?)	3,949–4,025
Knox dolomite	4,025–4,192
Showing of gas	4,038
1 barrel sulphur water per hour	3,972
Total depth	4,192
KNOTT COUNTY	
Inland Gas Corp.	
Virginia-Kentucky Coal Corp. No. 5	
Elevation: 1,128 feet	
Corniferous	2,845–3,165
Dark lime	3,470–3,510
Total depth	3,543

	Depths in Feet
LAUREL COUNTY	
Globe Oil & Gas Co.	
Nat Sewell No. 1	
Black shale	950
Clinton shale (Duffin in base)	1,053
Brassfield	1,195
Richmond	1,215
Maysville	1,400
Eden and Trenton	1,500
High Bridge	2,060
Everton (10 feet sand)	2,900
Knox	3,055
Total depth	3,220
MAGOFFIN COUNTY	
Cumberland Petroleum Co.	
L. C. Bailey No. 44	
Elevation: 1,018 feet	
Corniferous	1,690–2,240
Big Six	2,240–2,305
Brassfield	2,572
Richmond	2,615
Maysville	2,698
Eden	3,285
Trenton	3,550
Tyrone	3,907
Joachim(?)	4,725
Everton(?)	4,995
Knox	5,060
Total depth	5,080
MARTIN COUNTY	
E. E. Cunningham	
Sam Endicott No. 1	
Corniferous	2,930–3,669
Clinton sand	4,045–4,085
Total depth	4,148
Gas—4,080 feet—33,000 cubic feet	

The following is a résumé of the more important gas-producing counties of eastern Kentucky.

FLOYD COUNTY

The total number of wells drilled in Floyd County during 1941

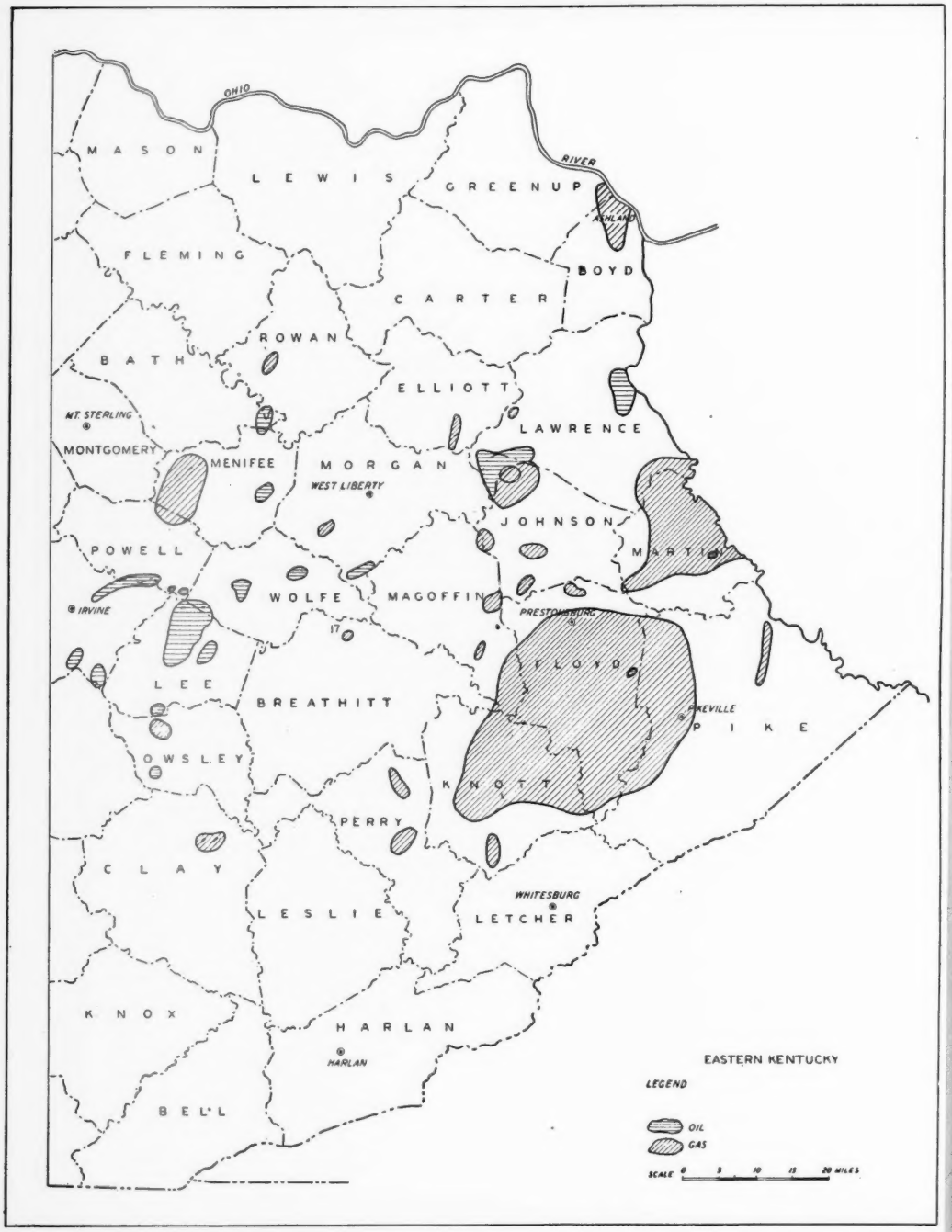

OHIO RIVER
MASON
LEWIS
GREENUP
ASHLAND
FLEMING
BOYD
CARTER
ROWAN
BATH
ELLIOTT
MT. STERLING
LAWRENCE
MONTGOMERY
MENIFEE
MORGAN
WEST LIBERTY
JOHNSON
MARTIN
POWELL
WOLFE
MAGOFFIN
PRESTONSBURG
IRVINE
FLOYD
LEE
BREATHITT
PIKEVILLE
PIKE
OWSLEY
KNOTT
PERRY
CLAY
WHITESBURG
LESLIE
LETCHER
KNOX
HARLAN
HARLAN
BELL
EASTERN KENTUCKY
LEGEND
OIL
GAS
SCALE 0 5 10 15 20 MILES

FIG. 3

was 72, of which 6 were dry, 1 was a 20-barrel oil well, and 65 produced gas from the following formations.

Number of Wells	*Formation*	*Combined Open Flow (1,000 Cubic Feet)*
2	Salt sand (Pennsylvanian)	723
3	Maxon (Mississippian)	2,538
11	Big lime (Mississippian)	13,549
49	Shale (Devonian)	14,904
	Total	31,714

The drilling in Floyd county was in proved territory.

JOHNSON COUNTY

Sixteen wells were drilled in Johnson County during 1941. Two were dry and 14 produced gas from the following formations.

Number of Wells	*Formation*	*Combined Open Flow (1,000 Cubic Feet)*
4	Shale (Devonian)	300
10	Big Six (Silurian)	3,000
	Total	3,300

There were no oil wells completed in Johnson County during 1941.

The Big Six sand production represents the discovery of the new Rockhouse Creek field 4 miles west of Paintsville.

KNOTT COUNTY

Forty-seven wells were drilled in Knott County during 1941. Two were dry and 45 produced gas from the following formations.

Number of Wells	*Formation*	*Combined Open Flow (1,000 Cubic Feet)*
0	Salt sand (Pennsylvanian)	
4	Maxon (Mississippian)	3,983
3	Big lime (Mississippian)	3,069
38	Shale (Devonian)	8,598
	Total	15,650

The larger part of this development represents wells in proved territory. However, there were some extensions to known fields.

MAGOFFIN COUNTY

In former years, approximately 1,200 wells were drilled for oil in Magoffin County. Of this number, 900 were Wier sand oil wells and 100 were dry holes.

In the extreme southern part of the county is the Fych gas field in which there are 53 wells producing from the Salt sand, Maxon, Big lime, Injun, and Shale formations. One gas well was completed during

1941 with an open flow of 298,000 cubic feet daily from the Devonian shale and Big Injun formations.

During 1941, the Cumberland Petroleum Company deepened an old Corniferous well to the Knox dolomite at the total depth of 5,080 feet. No commercial oil or gas was encountered.

MARTIN COUNTY

The total number of wells drilled in Martin County during 1941 was 42, of which 4 were dry, 6 produced oil, and 32 produced gas from the following formations.

Number of Wells	*Formation*	*Combined Open Flow (1,000 Cubic Feet)*
2	Salt sand (Pennsylvanian)	7,455
4	Maxon (Mississippian)	3,755
1	Big lime (Mississippian)	84
25	Shale (Devonian)	11,904
	Total	23,198

The 6 Maxon oil wells had a combined initial production of 122 barrels. This production is within a proved field.

PIKE COUNTY

Eighty-one wells were drilled in Pike County during 1941. Nine were dry and 72 produced gas from the following formations.

Number of Wells	*Formation*	*Combined Open Flow (1,000 Cubic Feet)*
11	Salt sand (Pennsylvanian)	4,594
14	Maxon (Mississippian)	14,416
2	Big lime (Mississippian)	3,682
45	Shale (Devonian)	19,191
	Total	41,883

Part of this production was from proved areas, but this county had more new development than any other county in the Big Sandy area.

TENNESSEE (EASTERN)

The production of crude oil east of the Cincinnati arch in Tennessee during 1941 was slightly more than 15,000 barrels, two-thirds of which were from the Mississippian limestone pools in Scott and Morgan counties. About a dozen scattered wells in Clay and Fentress counties, on the eastern Highland Rim, accounted for about 5,000 barrels. Small amounts of gas were produced for local consumption at Jamestown and Sunbright.

There were twelve wells spudded in during 1941 east of the Cincinnati arch, three of which were drilling or only temporarily sus-

SUMMARY OF 1941 DRILLING IN EASTERN KENTUCKY

County	Completions	Dry	Gas	Oil	Initial		Deepest Formation Tested	Drilling 12-31-41
					Gas (1,000 Cu. Ft.)	Oil (Barrels)		
Bath	8	0	8				Corniferous	
Carter	1	1	0	0			Corniferous	
Clark	1	1	0	0			Knox	
Clay	6	1	5	0			Corniferous	
Clinton	12	3	3	6	95	105	Tyrone	
Cumberland	8	2	0	6		55	Sunnybrook	
Elliott	3	1	1	1	150	10	Knox	1
Estill	54	5	0	49*		442	Corniferous	
Floyd	72	6	65	1	31,714	20	Devonian shale	15
Greenup	2	0	0	2		6	Berea	
Jackson	5	2	3	0	Gas		Corniferous	
Johnson	16	2	14	0	3,300		Corniferous	6
Knott	47	2	45	0	15,650		Devonian shale	14
Knox	4	0	4	0			Corniferous	1
Laurel	1	1	0	0			Knox	
Lee	22	1	0	21		76	Corniferous	
Lewis	2	2	0	0			Corniferous	
Lincoln	1	0	1	0	100		Corniferous	
Magoffin	2	1	1	0	298		Knox	
Martin	42	4	32	6	23,198	122	Clinton	11
Montgomery	1	1	0	0			Knox	
Morgan	4	4	0	0			Clinton	
Pike	81	9	72	0	41,883		Devonian shale	36
Powell	16	6	4	6	575	49	Corniferous	
Pulaski	4	3	0	1			Tyrone	
Rowan	1	0	1				Corniferous	
Wayne	6	2	0	4		18	Sunnybrook	
Total 27 counties	422	60	259	103	116,963	903		84

* 6 pressure wells included.

pended on December 31, 1941. None of the nine completions, which totaled 13,705 feet, could be classed as commercial producers, although a test in northwestern Scott County encountered a considerable amount of free oil at 850 feet. This showing is in a limestone of Chester, probably Glen Dean, age and is located in an area of Mississippian limestone production which was abandoned about 25 years ago.

There was little leasing in the area as a whole. The flashy production found in 1937–1938 in Clay and adjoining counties has been short-lived and the region is essentially abandoned. Failure to find steady production has been the major factor retarding developments in the northeastern Highland Rim area. Several blocks were assembled during the year and four tests were drilled, largely financed by local capital.

In the Cumberland Plateau area, several sizeable blocks of leases were renewed by one of the major companies. With the exception of

the developments in Scott and northern Morgan counties, the Cumberland Plateau, especially its pre-Mississippian possibilities, remains essentially unexplored. In the light of present and past Ordovician production at the northwest in the Highland Rim area of Tennessee and Kentucky, the plateau is considered one of the most favorable areas for prospecting in the state. Exploration in this region, however, will be largely dependent on the results of deeper drilling in southeastern Kentucky.

Maryland

One well was completed in the western Panhandle of Maryland. This well, located in the highly folded area of Garrett County, was completed at the total depth of 8,165 feet after encountering a showing of gas and salt water in the Oriskany sand at 8,096 feet.

Edward B. Mathews, director of the Board of Natural Resources of Maryland states that his department has no further record of drilling for oil or gas for the year.

Virginia

Two wells were drilled near the Appalachian structural front area in Virginia during the year. One of these wells was located on the Powell Valley anticline in Wise County and was a dry hole through the Devonian shale at the total depth of 5,348 feet.

The other, the J. F. Souders No. 1, located near Bergton in Rockingham County on a prominent anticline, encountered slightly less than 100,000 cubic feet of gas from the Devonian shale and Oriskany sand and was completed at the total depth of 2,986 feet, reportedly less than 2 feet in the Oriskany.

At the end of the year one well was being drilled a short distance from the Souders.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1135-1154, 2 FIGS.

CALIFORNIA EXPLORATION AND DEVELOPMENT IN 1941[1]

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ABSTRACT

California's decline in discovery rate was sharply checked in 1941. Thirteen new areas of production were officially acknowledged. Eight are definitely established as fields, this figure including one new gas field. The status of the remaining five remains unsettled either by virtue of their imperfect state of development, or because subsequent drilling may prove them extensions of old fields. In addition, there were discovered three significant extensions to old fields, and a deep zone in one of the new fields of this year.

Increase in discovery rate was associated with increased exploratory effort as indexed by wildcat drilling, geophysical activity, and geological employment.

Although numerically impressive, the addition to reserves by 1941 discoveries was disappointing, amounting to a tenth or less than the year's production. Nevertheless, the year's record of improved discovery rate is encouraging, and implies that we may reasonably expect discoveries to continue with perhaps an occasional one of major proportion.

The problem of diminishing rate of supply is briefly examined.

GENERAL

The declining rate of discovery in California continued from its 1936–1937 peak to a low in 1940 of only one new field discovered. In 1941 this trend was abruptly reversed by the discovery of seven oil fields and one gas field, and by the discovery of five additional new areas of production. Within each of the latter but one well had been completed.

Contributory to, and yet in part dependent on this improved discovery rate was generally increased activity in related lines of effort. Wildcat wells completed during the year numbered 101 as compared with the 78 reported in 1940. Geophysical activity changed from 16 parties employed at the beginning of the year to 25 at the end of 1941. Geological activity, as evidenced by several indices of employment, showed an increase of 4.5–6.5 per cent over the year preceding.

Increased exploratory activity during 1941 was accompanied by a milder but increased activity in proved field development. Fifty-one more producing wells were completed than during the year preceding. Wilmington and Coalinga were again the first and second most active fields in the state, with the Santa Maria Valley field replacing Coles Levee as having the third largest number of wells completed during 1941.

[1] Presented before the Association at Denver, April 22–24, 1942. Manuscript received, April 12, 1942.

[2] The Texas Company.

Voluntary curtailment was effective throughout the year—seemingly with some success in that the top allowable figure appears to have become more stabilized. Starting with 148 barrels per day for the maximum allowable figure in January, this quota had, by December, suffered only a 9-barrel reduction.

Certain trends established in years previous continued through 1941. Accordant with the growing demand for petroleum was an increasing rate of production on the one hand, coupled with an accelerating rate of total withdrawals from storage on the other. Daily production, as expressed by month-to-month averages, increased from 609,000 barrels a day at the beginning of the year to a maximum of 651,000 barrels a day during October. The annual production of 230 million barrels exceeded that of any of the 10 years past excepting for the flush period of 1937–1938. Total stocks in storage were reduced by approximately 8 million barrels—a volume equivalent to the better part of the state's production for $\frac{1}{2}$ month. This over-all reduction of storage took place in virtually every line of petroleum products. The chief commodity withdrawn was residual fuel oil, to the amount of $6\frac{1}{2}$ million barrels, of which, under the existing conditions, there is a rapidly growing need.

The fast mounting requirements for fuel imposed by normal growth as well as defense industry, together with those of the military, have directly as well as indirectly affected the market for natural gas. These developments, plus certain measures directed toward the conservation of gas within oil fields, either effective or programmed, have reacted to the additional advantage of the dry-gas industry.

To supply this growing demand there were during the past year more dry gas wells completed than in any year previous, excepting 1935, and from the standpoint of having added producing capacity, the state enjoyed one of its most successful periods. This added capacity, however, resulted almost entirely from the routine development and the extension of reserves in the great Rio Vista gas field, discovered 5 years previously.

New types of equipment introduced and used in California were radioactive logging, chiefly in proved fields, and the increased, though by no means general, use of sidewall coring. A definite increase in the use of portable drilling equipment of varying types of construction, and a reduction in hole size and an improving skill in bit selection, have all combined to reduce drilling time. Decreased mud costs, fewer bits, and lessened fuel consumption have resulted therefrom, which, with a general tendency toward the use of smaller casing, have all tended toward a reduced over-all cost per foot of hole in the completed

well. Certain innovations, still more or less in the experimental stage, have been introduced in geophysical equipment. Perhaps the most promising is variable frequency selectivity whereby certain reflections can be enhanced at the expense of others. Perfected, this type of selectivity will be of utmost value in solving fault problems.

Among the proved fields a development program began which may ultimately be of far-reaching significance. With full approval of the Navy Department, a major company began drilling wells on its properties contiguous with the Elk Hills Naval Reserve. No details of the operations are available other than that by the end of the year eight wells had been completed, of which two were deep tests, with a third deep extension well drilling which has since been completed.

DISCOVERIES

At the beginning of 1941, 39 wildcat wells were drilling. At its end 28 were active. In between, 87 dry holes had been completed and 13 discoveries announced. Eight of the discoveries are proved fields of which one is a gas field. The remaining five, in the interests of conservatism, are merely called areas of production since they contain, as yet, only the original discovery well. The factor of success was therefore one to eight; that is, one discovery to every eight wildcat wells. There was in addition a sub-commercial discovery in a new area. During the same period, three important field extensions have been established and a new deep zone discovered.

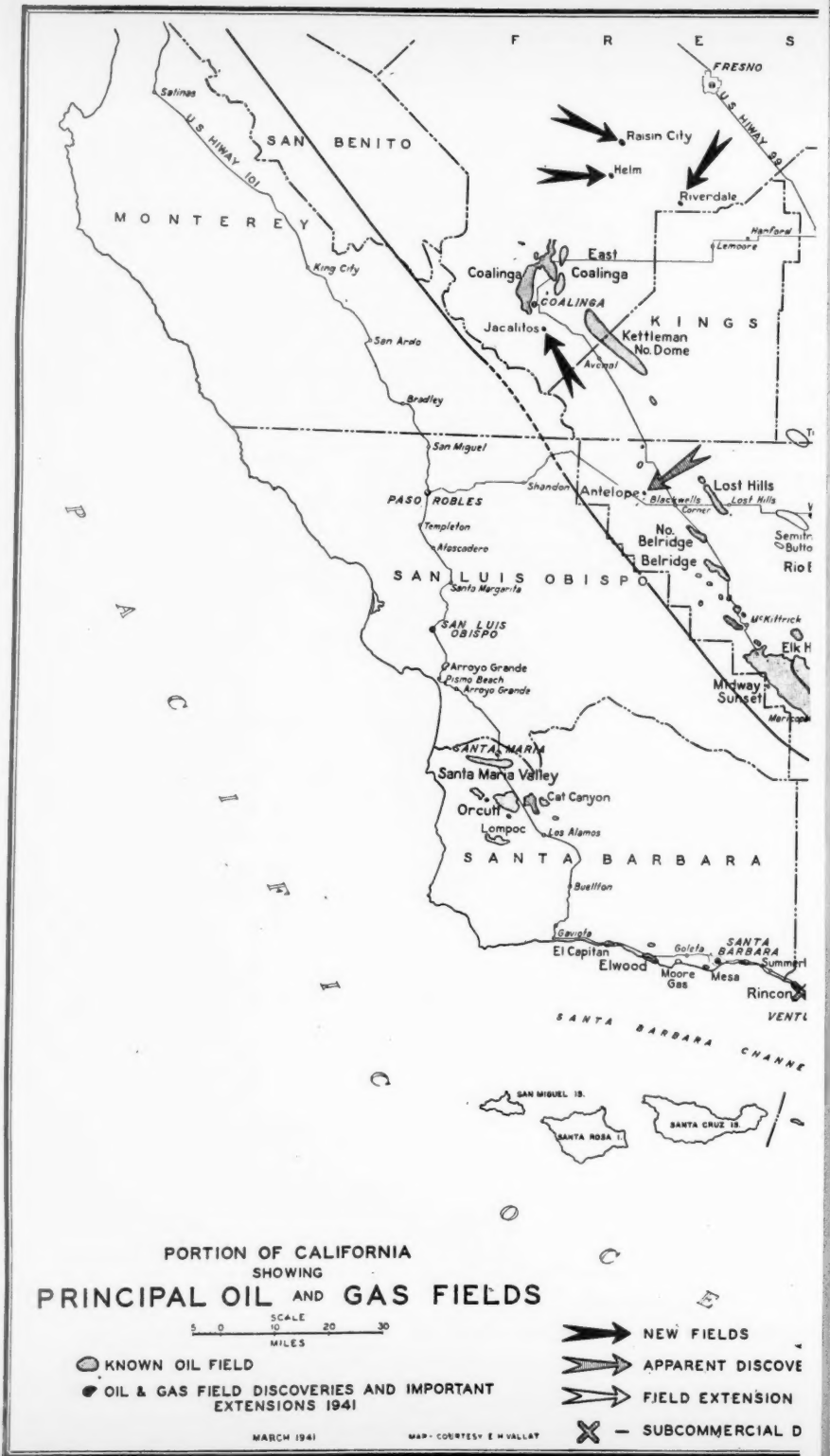
Geographically these discoveries range from the farther reaches of the Los Angeles Basin northward to Sonoma County, beyond San Francisco Bay, and were distributed through three of the four principal oil-producing provinces of the state, as well as adding a substantial extension to one.

These discoveries are of two distinctive types resulting from (1) detailed seismograph explorations in areas relatively remote from the scene of previous seismograph successes, and (2) a re-inspection and more critical examination of regions previously prospected, the new producing areas generally being in the near vicinity of wells having showings.

Four of the new-found areas are attributable to the seismograph; the remaining nine are the result of carefully applied field and subsurface geology.

Last year Vallat[3] predicted that with geological employment remaining the same, yet with decreased well and geophysical activity,

[3] Eugene H. Vallat, "California Exploration and Development in 1940," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 6 (June, 1941), p. 1159.


F R E S
FRESNO
U.S. HIWAY 99
Salinas
U.S. HIWAY 101
SAN BENITO
Raisin City
Helm
Riverdale
MONTEREY
Hanford
Lemoore
East Coalinga
Coalinga
COALINGA
King City
Jacalitos
KINGS
Kettleman No. Dome
Avenal
San Ardo
Bradley
San Miguel
Shandon
Antelope
Lost Hills
Blackwells Corner
Lost Hills
PASO ROBLES
Templeton
Atascadero
No. Belridge
Belridge
SAN LUIS OBISPO
Santa Margarita
McKittrick
SAN LUIS OBISPO
Arroyo Grande
Pismo Beach
Arroyo Grande
Midway Sunset
SANTA MARIA
Santa Maria Valley
Cat Canyon
Orcutt
Lompoc
Los Alamos
SANTA BARBARA
Buellton
Gaviota
El Capitan
Goleta
SANTA BARBARA
Elwood
Moore Gas
Mesa
Summerland
Rincon
VENTURA
SANTA BARBARA CHANNEL
SAN MIGUEL IS.
SANTA ROSA I.
SANTA CRUZ IS.
PACIFIC OCEAN
PORTION OF CALIFORNIA
SHOWING
PRINCIPAL OIL AND GAS FIELDS
SCALE
5 0 10 20 30
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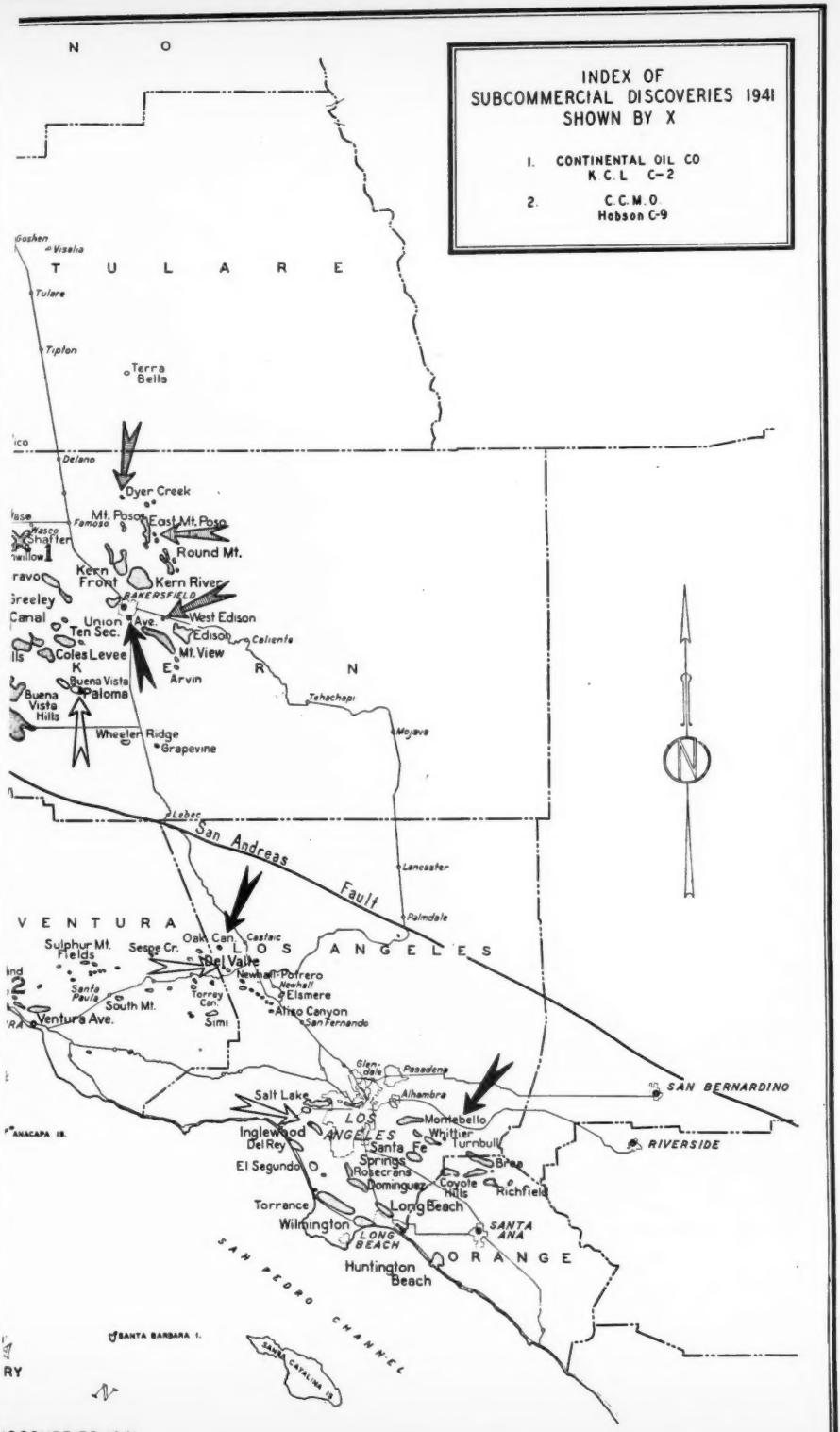
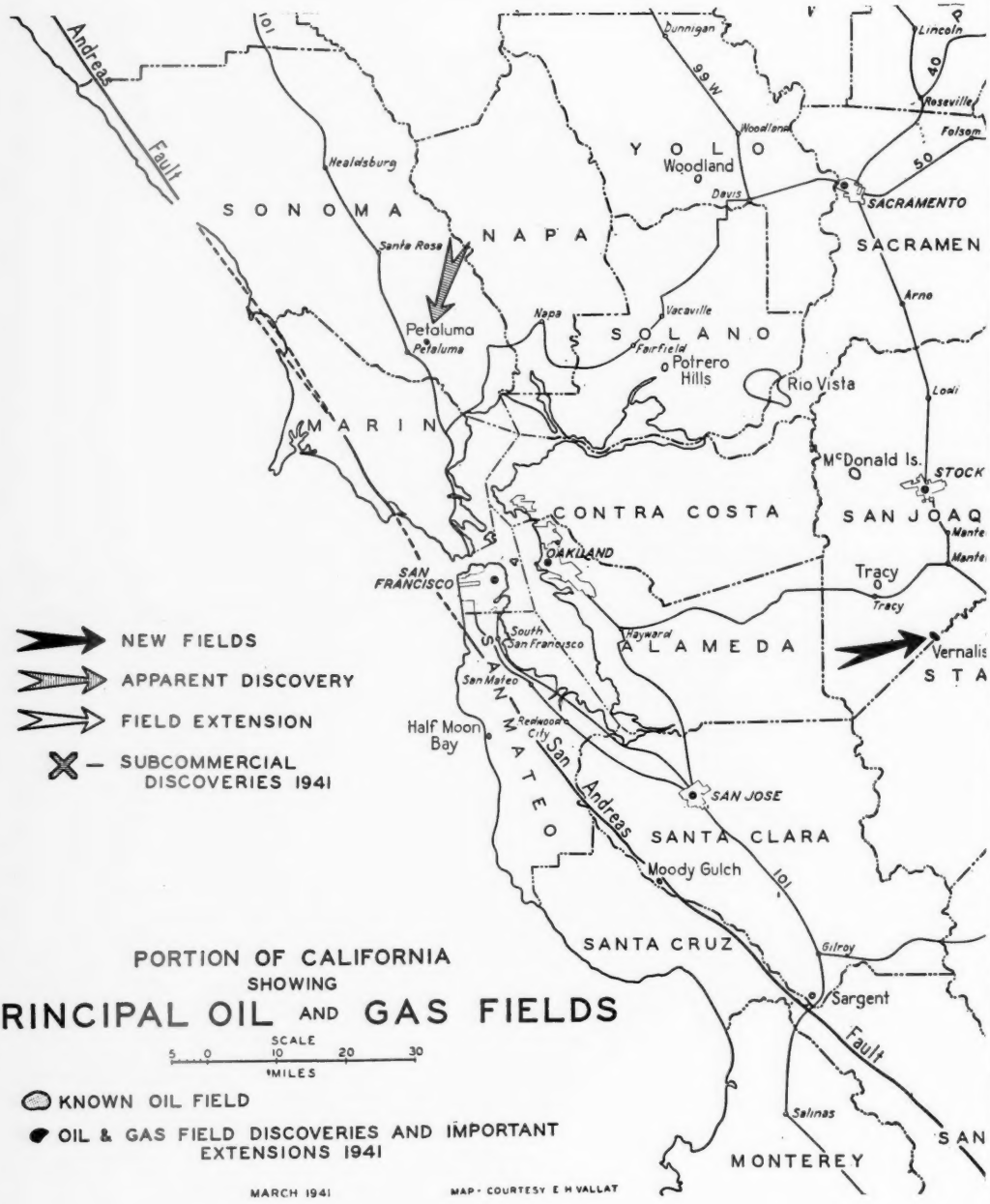
KNOWN OIL FIELD
OIL & GAS FIELD DISCOVERIES AND IMPORTANT EXTENSIONS 1941
MARCH 1941
MAP - COURTESY E. H. VALLAT
NEW FIELDS
APPARENT DISCOVE
FIELD EXTENSION
SUBCOMMERCIAL D

FIG. 1



ISCOVERIES 1941


Andreas
Fault
101
Healdsburg
SONOMA
Santa Rosa
NAPA
Petaluma
Petaluma
Napa
Vacaville
SOLANO
Fairfield
Potrero Hills
MARIN
Dunnigan
99 W
YOLO
Woodland
Woodland
Davis
Lincoln
40
Roseville
Folsom
50
SACRAMENTO
SACRAMEN
Arno
Rio Vista
Lodi
McDonald Is.
STOCK
CONTRA COSTA
SAN JOAQ
Mante
Mante
OAKLAND
SAN FRANCISCO
Tracy
Tracy
South San Francisco
Hayward
ALAMEDA
Vernalis
STA
San Mateo
Half Moon Bay
Redwood City
SAN MATEO
San Andreas
SAN JOSE
SANTA CLARA
Moody Gulch
101
SANTA CRUZ
Gilroy
Sargent
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NEW FIELDS
APPARENT DISCOVERY
FIELD EXTENSION
SUBCOMMERCIAL DISCOVERIES 1941
PORTION OF CALIFORNIA
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SCALE
5 0 10 20 30
MILES
KNOWN OIL FIELD
OIL & GAS FIELD DISCOVERIES AND IMPORTANT EXTENSIONS 1941
MARCH 1941
MAP - COURTESY E H VALLAT

FIG. 2

more subsurface and field geology, as such, should result. His conclusion appears correct. The past year's record seems to present evidence of the ability of the geologist to continue to find oil when more time is available to him for the consideration of data already at hand.

VERNALIS FIELD

This was the first discovery of the year. Situated in San Joaquin County, in the north-central part of the San Joaquin Valley, the Standard Oil Company's Blewett Community well No. 1, Sec. 25, T. 3 S., R. 6 E., M.D.B. & M., was completed from a depth of 3,873 feet as a dry gas well at a producing rate of 9,300,000 cubic feet through a $\frac{5}{8}$-inch bean. Flow and shut-in pressures were respectively 1,100 and 1,650 pounds. The productive zone is 13 feet of Moreno sand of Upper Cretaceous age. Later, a second well was drilled within the same section to a depth of 5,506 feet, but, following a series of formation tests of lower sands, was plugged back to the original sand and completed at a depth of 3,869 feet.

The structure is said to be a dome of moderate closure, with discovery attributable entirely to the seismograph. At the end of the year the field had only the two completed gas wells.

UNION AVENUE FIELD

Union Avenue was California's first oil discovery of the year. It is on the south outskirts of the city of Bakersfield, near the southeastern edge of the San Joaquin Valley. The discovery location was partly encircled by seven dry holes, none distant more than $\frac{1}{2}$ mile and all of which reached at least one of the two productive zones. The Hancock Oil Company's Roberts well No. 1, Sec. 6, T. 30 S., R. 28 E., M.D.B.&M., was completed on the pump, in late January, from 40 feet of Santa Margarita sand producing 150 barrels daily of 14.8° gravity oil, cutting 28 per cent which later cleaned to 0.5 per cent. The final completion depth was 5,312 feet, after having been plugged back from a total depth of 5,599 feet.

Post-discovery development of a shallower zone, cored but untested in the first well, has been effected from 50 feet of zone in the overlying continental Chanac series. Here the initial completion flowed 130 barrels daily of 25.5° gravity oil, accompanied by 500,000 cubic feet of gas.

Accumulation is conditioned by obscure faulting, apparently of moderate displacement. Regionally, the field is situated on the monoclinal south flank of the great Bakersfield salient. The lower productive zone is upper Miocene in age, whereas the shallow zone is undifferentiated lower Pliocene-upper Miocene in age. Discovery was

the result of careful study of previous well records, joined with a structural interpretation of the topography in the immediate vicinity.

At the end of the year two wells were being drilled and three had been completed, two from the upper, and one from the lower zone.

OAK CANYON FIELD

The Oak Canyon field, in Los Angeles County, is in the upper reaches of the Santa Clara Valley. Its discovery indirectly stems from California's sole discovery of last year, the near-by Del Valle oil field. The Western Gulf's Lechler well No. 1, Sec. 31, T. 5 N., R. 17 W., S.B.B.&M., on February 1 was completed on the pump, at a 100-barrel per day rate of 22.5° gravity oil, cutting 20 per cent. Production is derived from 56 feet of sandy zone. The well was drilled to 2,442 feet and plugged back to 2,410 feet for completion. The age of the producing zone is upper Mohnian (middle upper Miocene).

This shallow discovery zone was missing in the Western Gulf's next test, Lechler well No. 2, which was then deepened to 7,178 feet, and, following several formation tests, plugged back to 6,940 feet. Here it was completed in early July from the topmost 37 feet of a 275-foot sand zone. Initial flow from this new and lower zone was at a 960-barrel-per-day rate of 31.5° gravity clean oil through a $\frac{3}{4}$-inch choke. It is basal lower Mohnian, that is, lowermost upper Miocene. Formation tests, cores, and electric logs indicate the probable presence of several as yet untested zones intermediate between the two thus far demonstrated.

The field is located in Pliocene sediments on the surface axis of an east-plunging anticline. Despite fairly active development, the real basis for accumulation still remains obscure. However, in the face of very evident lensing in the entire section, not only here but elsewhere throughout the area, it is believed that anticlinal structure, the known textural changes, and perhaps some faulting compose the essential factors conditioning accumulation. The end of the year found the field with four completed producers: two from each zone; one drilling well; and a suspended, apparently dry, hole.

Discovery is directly attributable to field work joined with a small measure of subsurface information concerning old wells in the area.

RAISIN CITY FIELD

Discovery of oil at Raisin City refuted one of orthodoxy's deepest-rooted fancies—that oil would never be found north of Coalinga. Actually, the well is 25 miles northeast of the Coalinga fields at a mid-valley location between them and the city of Fresno.

The Shell Oil Company, Inc., Properties Inc. well No. 8-18, Sec. 18, T. 15 S., R. 18 E., M.D.B.&M. in Fresno County, after being drilled to 6,429 feet to the Eocene sand, was completed from a depth of 5,045 feet from a 40-foot sandy zone. Initially the well blew gas and a spray of oil and, for a short period, flowed at a 14,600,000-cubic-foot rate through a $\frac{5}{8}$-inch bean. A few days later the well steadied to a production of 20–30 barrels daily of 23°–27.7° gravity clean oil accompanied by 1,300,000–1,400,000 cubic feet of gas.

The oil and gas are produced from continental beds equivalent to the Temblor (middle and lower Miocene) of the Coalinga region. Two productive zones, each 35–75 feet thick, have been developed. Individual sands within these zones are thin, the amount of sand open in the ordinary well being about 20 feet. Better completions in the field average 250–350 barrels per day of 22°-24° gravity oil. Thinness and lenticularity of the sands, together with their close association with intermediate waters, have necessitated a careful operating technique. The thin sands, the seeming restricted areal extent of the productive area, and the low yield, initially as well as ultimately, have been disappointing.

The field is a seismograph discovery, the pre-drilling picture of which indicated a structure of low closure. Field development thus far appears to be limited to its southeast plunge, with only 25 feet of structural relief between the highest producing well and a close-in dry hole. Eight producing wells composed the field at the end of the year, in addition to one dry hole and one well drilling. The number of wells drilled in this field exceeds that of any other newly found field of 1941. Development was proceeding until the end of the year on a 20-acre spacing.

PETALUMA AREA

The Trico Oil and Gas Company's Miller well No. 1 in Sonoma County, Sec. 30, T. 5 N., R. 6 W., M.D.B.&M. (projected), was completed in late August from a depth of 1,214 feet, flowing at a 3 million-cubic-foot rate through a $\frac{5}{8}$-inch surface bean under 347 pounds flow pressure. Shut-in pressure was 541 pounds. The gas is dry with a BTU. content of 1,047. Production is derived from 30 feet of sand, 1,184 to 1,214 feet, occurring within the fresh-water beds of the Petaluma series of middle Pliocene age. The well is said to be located on a relatively narrow and sharp folded anticline. To what extent production is affected by faulting, which is known to be present, and lenticularity, which is marked in the Petaluma beds, is unknown.

Only $4\frac{1}{2}$ miles northeast of the town of Petaluma, this local market

and immediate access to near-by pipeline facilities appear to have justified this modest completion.

The principal significance attached to the discovery is that it is the first commercially successful enterprise to be completed in the region.

This discovery results from careful field work supplemented by records of old wells drilled in the vicinity, several of which either blew out or had substantial showings, sometimes of oil. None but the discovery well had been drilled by the end of 1941.

DYER CREEK AREA

Late in September, the Shell Oil Company, Inc., completed its Smith No. 56-X-11 core hole, Sec. 11, T. 26 S., R. 27 E., M.D.B.&M., in the shallow Vedder producing district of the San Joaquin Valley, East-side. The discovery well is 2,361 feet deep, the oil coming from 18 feet of typical Vedder sand (lower Miocene) topped at 2,343 feet. Completed on the pump, its initial rating was 163 barrels a day of 15.2° gravity oil, cutting 17 per cent. Later the well established a top production figure of 270 barrels per day, gross, of 15.3° gravity oil with a 22.5 per cent cut, much of which was sand.

At the time of discovery, entrapment was believed to be effected by two intersecting faults, both upthrown on the downdip side of the monocline which is here the prevailing regional structure. This type of trap is the one from which nearly all shallow East-side Vedder sand oil is produced. By the end of the year, a second well, just northwest of the first, had been drilled and abandoned. It found 13 feet of poor oil sand but was structurally low. Following this, it appeared that the fault pattern was more intricate than was at first believed.

The discovery resulted from careful subsurface geology preceded by two dry core holes, both of which reached the objective sand. With faulting established, the discovery drill-site was then selected between them.

HELM FIELD

If interest only smoldered following discovery of Raisin City in the north-central valley region, it can be said to have broken into open flame following discovery of the near-by Helm field.

The Amerada Petroleum Corporation's Clover No. 31-34 well, Sec. 34, T. 16 S., R. 17 E., in Fresno County, after reaching 10,255 feet, cemented casing at 8,053 feet. Then, in quick succession, three separate thin zones were gun-perforated and individually tested, each producing distillate and considerable gas. Depths of these several

producing intervals ranged from 7,300 to 8,005 feet, the lowest being 10 feet of Eocene sand, whereas the upper are 13- and 17-foot stringers of sand within the lower Temblor (middle lower Miocene). The well was completed from the highest of these. A flow test conducted after completion established a daily rating of 662 barrels of 64.7° gravity oil through an 82/64-inch bean, together with 13,618,000 cubic feet of gas.

The structure appears to be a dome of low relief, perhaps faulted on its north flank. Discovery resulted from seismograph work. Development at the close of 1941 consisted of one completed and two drilling wells, one of the latter being later completed and the other abandoned.

JACALITOS FIELD

The Wilshire Annex Oil Company's No. 33-26-E well, Sec. 26, T. 21 S., R. 15 E., Fresno County, was drilled to 6,031 feet in search of Eocene production and missing this, was plugged to the top of the Temblor and completed. From a depth of 3,905 feet, with 20 feet of sand open, the well flowed 72 barrels its first day. Later, on the pump, the well established an 80-barrel per day rate of 40.4° gravity oil, cutting 0.1 per cent.

Discovery resulted from careful scrutiny of old abandoned well histories. The Wilshire's first well was drilled near a cluster of four of these old wells. Structurally, the new field is located on a prominent anticline of strong southeast plunge with small or dubious closure at the producing zone. An unconformity exists at the top of the pay zone, beveling the oil measures. This tendency to pinch out up the plunge is believed to be the principal factor affecting the accumulation.

Besides the discovery well, a second well by the end of the year had been drilled and was standing cemented on the sand.

TURNBULL CANYON FIELD

The Turnbull Canyon field, the first completely new area of production to be discovered in the Los Angeles Basin for several years, lies along the north edge of the Puente Hills, 20 miles east from the center of Los Angeles. Discovery was effected by the Continental Oil Company in its Turnbull Community well No. 1, Sec. 13, T. 2 S., R. 11 W., S.B.B.&M., bottomed at 3,447 feet and completed on the pump, October 18, 1941, with an initial output of approximately 130 barrels per day of 25.2° gravity oil, cutting 4.2 per cent. Later, the well established a settled daily rate of 237 barrels, but with cut increased to 19 per cent.

This well disclosed a general zone of saturation within the Syca-

more Canyon and upper Puente formations (upper Miocene) composed of alternating shales, streaks of oil sand, and some gray sand, extending from 3,281 feet to the bottom (3,447 feet). The completion of the well was accomplished in the lowest 69 feet of this zone, averaging 60 per cent of sand.

As mapped at the surface, the field is on a northwest-southeast-trending anticline whose southwest flank is cut by a fault of considerable size which parallels the anticlinal axis. The productive area is on the downthrown side of the fault which is believed to dip northeast. The northeast flank and northwest plunge of the structure are regional, the seismograph being used to confirm the alluvium-covered southeast plunge, which field work suggested but could not conclusively prove. Expressed in barest essentials, the accumulation appears effected by a structural convexity existing against, and sealed by, the fault.

At the end of 1941, two wells were being drilled in the area: one an immediate offset on the southwest, and another $\frac{3}{4}$-mile extension well on the northwest.

Development after the first of this year indicates that discovery of a deeper zone was impending at that time in the Continental's second well, diagonally offsetting the discovery.

Field work is to be given credit for the discovery, supplemented by the seismograph.

ANTELOPE AREA

Based on projected surface geology with a certain measure of subsurface geology and some geophysics, Etienne Lang undertook his Occidental well No. 1, Sec. 30, T. 26 S., R. 19 E., M.D.B. & M., in Kern County. After being drilled to 2,208 feet, the well was plugged back to 1,000 feet at the base of 150 feet of saturated and remarkably well sorted oil sand at the base of the Miocene. In mid-November the well went on the pump at a 51-barrel daily rate of 13.5° gravity oil, cutting 5 per cent sand. Because of liner and sand trouble, production eventually declined to 5–7 barrels per day. Since that time, between epidemics of experiment and trouble, the well has intermittently produced with an indicated capacity of approximately 25 barrels per day of clean oil.

At the end of the year Lang was drilling Occidental well No. 2 which found 88 feet of good oil sand between 1,220 and 1,318 feet. Water developed on the initial test which, because of mechanical conditions within the hole, has never been located and the well was suspended without further adequate tests or repairs. Structurally, development appears to be in the trough of an open, southeast-plunging

syncline with its head and the associated oil sands truncated by water-free alluvium, with perhaps a thin sheet of Pliocene intervening. Thus, in effect, productive conditions appear to be the same as those which would be encountered by a well drilling directly downdip from outcropping tar sands.

EAST MOUNT POSO AREA

Bradford Bishop, allied with the Signal Oil Company interests, in late November completed on the pump his Glide well No. 1, Sec. 22, T. 27 S., R. 28 E., Kern County, from 14 feet of Vedder sand (lower Miocene). The bottom of the hole is at 1,434 feet; the top of the sand at 1,420 feet. The well established on test a potential rating of 377 barrels per day of clean 15.8° gravity oil.

The well is located in the heart of the East-side Vedder producing district, approximately midway between the old Mount Poso and Round Mountain fields and just northwest of the smaller Dorsey field.

Discovery resulted from careful field work by geologist Bishop in tracing the controlling fault of the Dorsey pool northward. The discoverer's pre-drilling picture was that of the ordinary type of fault intersection which provides the structural basis for most shallow Vedder accumulations. Opinion is divided about the presence of the spur fault postulated as separating this area from the adjoining field on the south. Some uncertainty exists, therefore, whether this new well has actually established a new accumulation or whether it is merely an extension of the adjoining field on the south.

At the end of the year, the discovery well was the sole well in the area. Delay in development arises from the necessity of getting exceptions to the Petroleum Co-ordinator's M-68 decree. Operators hope to drill on a ten-acre spacing because of the limited size of the pool.

RIVERDALE FIELD

In mid-December, the Amerada Petroleum Corporation completed the third discovery well of the year in Fresno County. Lawton No. 45-26 well, Sec. 26, T. 17 S., R. 19 E., was drilled to 8,311 feet. Following the technique used at Helm, casing was cemented at 8,116 feet, testing the zones of interest by selective gun-perforating. All zones thus tested were thin and none produced oil except the last and highest in the interval from 6,665 to 6,685 feet. From this zone the well produced with an initial rating of 558 barrels per day, of 34.0° gravity oil, cutting 0.4 per cent through a $\frac{1}{4}$-inch choke. Like its companion discoveries, Raisin City and Helm, the Riverdale field produces from the Temblor formation (middle and lower Miocene). The 18 feet of pro-

ducing sand occurs near the center of this formation. It is only one member of a group of several sands which later, in subsequent wells, may be productive.

The structure is a low-amplitude fold with moderate closure which is said to encompass a considerable area. At the end of the year there was, besides the producing well, a second offset well drilling. On the basis of preliminary performance of the offset well after the beginning of the year, the field has promise of being the most important discovery of 1941.

WEST EDISON AREA

J. Paul Getty, on December 26, effected the last discovery of 1941 in his Portals Corporation well No. 1, Sec. 6, T. 30 S., R. 29 E. Although located near the old Mountain View and Edison fields in Kern County, the well is believed to produce from a slightly different zone. It was drilled to 4,257 feet, being completed from 162 feet of zone at the bottom of which were 50 feet of relatively continuous Wicker oil sand (lowermost upper Miocene). The well flowed initially at a 125-barrel per day rate of clean 19.2° gravity oil but was soon after put on the pump, eventually settling to a 50-barrel per day rate of clean 19.7° gravity oil.

It remains for future development to determine whether this well is a new discovery or merely an extension to an old, spottily productive area updip. Current conception of the geology is that of an accumulation caught in the updip angle formed by the intersection of the feather edge of the Wicker sand and a northwest-southeast trending fault.

SIGNIFICANT FIELD EXTENSIONS

Three significant field extensions were developed during the year. Geographically, they were distributed in the three most important producing basins of the state, from the Los Angeles Basin through the eastern end of the Ventura Basin and in the San Joaquin Valley. At the beginning of the year, three significant extension wells were drilling near or in previously proved areas. At the close of 1941, nine such wells were being drilled. In the interim, ten extension wells had been completed, of which three were classed as discoveries. Arranged chronologically, these are described in the following paragraphs.

PALOMA FIELD EXTENSION

In March, the Western Gulf Oil Company completed its KCL No. B-12-12 well, Sec. 12, T. 32 S., R. 26 E., M.D.B. & M., Kern County, and in so doing, extended the Paloma field one mile southeast of the

nearest production. The completion depth was 10,752 feet with top of the first oil sand encountered at 10,248 feet. On a 5-hour gauge the well was rated at 575 barrels daily, of 52.4° gravity distillate through a 20/64-inch choke, together with 2,900,000 cubic feet of gas.

Significance attaches not to the distance of this well from nearest production but to the fact that it found 90–125 feet of new sand. Known as the B-12 sand, this new member at this location is continuous with, and immediately overlies, the Paloma producing zone proper. Its areal distribution is, however, of a different configuration from that of the zone already productive. The new sand does not mantle the top of the structure but appears draped along its northeastern flank and around its eastern plunge. It is believed possible that its downdip producing limits will extend umbrella-wise beyond those of the Paloma zone proper.

By the end of the year, two subsequent wells, a mile removed from the discovery site, had explored this sand. Both were at a considerably lower structural elevation and both appeared wet. Despite this fact, the strong probability that a tilted water-table exists, and perhaps some faulting, make it appear that a considerable addition to the reserves of the field has been effected by this completion.

INGLEWOOD NORTHWEST EXTENSION

On March 5, the Federal Oil Company, after a prolonged period of fishing, redrilling, and delay, completed its Smith well No. 1, Sec. 7, T. 2 S., R. 14 W., S.B.B. & M., at the northern outskirts of the old Pliocene pool of the Inglewood field, in Los Angeles County. The new extension well produced 2,000 barrels, gross daily rate, of 31.1° gravity oil through a 1½-inch choke, accompanied by 2,300,000 cubic feet of gas. A 17 per cent cut soon cleaned up after completion.

This discovery well is at the extreme outer and northwestern edge of the established Pliocene production and, as later developed, on the northeast edge of the deeper Miocene pool. It is 1¼ miles removed, and completely across the field, from the R.R. Bush Oil Company's Sentous well No. 1 which is at the southeast edge of the field. This latter well in 1940 discovered, and gave name to, the deep zone to which this new well constitutes an important extension.

The Smith well was completed at a depth of 8,337 feet, producing from 413 feet of zone containing approximately 170 feet of sand. The age of the deep sand zone is middle Miocene (*Valvulineria californica* equivalent, and possibly including some beds slightly higher stratigraphically). The zone thus developed is equivalent, in part at least, to the Sentous zone at the other end of the field. In this well the top

of the new zone is about 2,200 feet stratigraphically below the top of the old Rubel zone of Pliocene age.

Development by the end of the year had disclosed that the Sentous zone was irregular in character, with permeabilities and porosities in general decreasing toward the southeast, although there are exceptions to this generalization. As developed at this time, the zone varies from 250 to 425 feet in thickness, containing variable quantities of sand, ordinarily between the limits of 75 and 175 feet and averaging 125 feet. Initial completions in the deep zone range from 250 to 3,000 barrels a day of 30°–32° gravity oil. Pressure within the zone is high, often exceeding normal hydrostatic pressures. The marker bed most commonly used in the deep development is the top of the "Nodular shale" which generally occurs 100–200 feet above the top of the Sentous zone.

The structural character of the deep pool as thus far delineated appears to be that of a northwesterly plunging anticline whose northeast flank is overthrust from the northeast, production being on the southwest, downthrown side. Productive structural relief in the northwest extension area as developed at the close of 1941 approximated 350 feet.

The Inglewood deep zone extension constituted the most actively exploited of any of the new developments of 1941. By the end of the year sixteen producers had been completed, three were drilling, and two dry holes had been drilled.

DEL VALLE EXTENSION

In early July, the Fred S. Jasper Petroleum Corporation's Videgain well No. 1, Sec. 17, T. 4 N., R. 17 W., S.B.B. & M., extended the Del Valle field—California's single discovery of 1940—1¼ miles west. The well was drilled to 6,078 feet, later being completed from a plugged depth of 5,994 feet from 104 feet of zone, producing 420 barrels per day of 31.5° gravity oil, cutting 2.8 per cent, with an estimated 1,500,000 cubic feet of gas.

Production is derived from upper Delmontian beds of the Modelo series (uppermost Miocene). Subsequent drilling has shown the total oil zone to be 100–150 feet thick, with initial yields varying from 420 to 1,500 barrels per day, of 31.5°–43.5° gravity oil. It is believed to correspond with the upper or Sherman zone of the adjoining Del Valle field.

The discovery well was located on the western continuation of the east-west-trending surface axis of the Del Valle anticline. The area is one of extreme lithological variation, not only within the pay zones,

but throughout the section. Lenticularity alone, or its combination with certain faults known to exist in the area, may cause the accumulation. The answer to this question must await further developments.

At the end of the year there were, in addition to the discovery well, three completed producers and three drilling wells. One well, prior to completion from the regular zone, had explored ahead 1,600 feet without discovery of new pay zones.

Field geology, coupled with a thorough subsurface study of the developing Del Valle field, is responsible for this discovery.

DEEP-ZONE DEVELOPMENTS

On January 1, 1941, seven deep-zone tests of proved areas were active; at its close there were only four. During the year sixteen had been completed. This figure includes the Oak Canyon deep zone discovery well and also the sub-commercial discovery of a deep zone in the Rincon field. Both of these are in the Ventura Basin. Details of the outcome of several deep tests conducted at Elk Hills are not available. By the end of 1941, 18 fields had been, or were being prospected, of which nine could be said to be of major size. This mode of wildcatting has been, in years past, California's most consistent formula for adding new reserves. This year it was singularly unsuccessful, with but one worth-while discovery resulting.

OAK CANYON FIELD DEEP ZONE

The Western Gulf Oil Company's Lechler well No. 2, Sec. 31, T. 5 N., R. 17 W., S.B.B. & M., Los Angeles County, effected in early July a deep-zone discovery in the Oak Canyon field. The well was drilled to 7,178 feet, approximately 4,800 feet deeper than the shallow zone, the discovery of which marked Oak Canyon as a field. The Lechler productive zone, as thus discovered at 6,905 feet, is composed of the topmost 37 feet of a sandy zone 275 feet thick or more, containing a net total of 200 feet of sand. Further details of completion of this well have been previously discussed under the heading of the Oak Canyon field. Following this discovery, a program of active development has been prosecuted, with most of the wells completed in the deeper and more prolific Lechler zone.

SUB-COMMERCIAL DISCOVERIES

SHAFTER AREA

The Continental Oil Company, during late September, completed its KCL No. C-2 well, Sec. 35, T. 27 S., R. 24 E., M.D.B.&M., and became the discovery well of the Shafter area. It lies approximately midway between the Rio Bravo and Wasco fields on the Greeley-Wasco trend. The well drilled to a total depth of 12,936 feet and, after

a complicated history, was completed with bottom plugged to 12,811 feet and producing from 11 feet of sand within the Vedder zone (lower Miocene). The first 24-hour gauge indicated a gross flow of 607 barrels of 36.8° gravity oil, cutting 12 per cent, accompanied by an estimated 600,000 cubic feet of gas. Subsequent to this completion, water troubles developed, and the well was recompleted from the same interval, flowing 532 barrels per day of 36.1° gravity oil, with the cut decreased to 9.5 per cent. In early December the well died and the end of the year found preparations started for the installation of a gas lift. At this latter date a second well was being drilled below 9,000 feet.

Discovery was based on seismograph work indicating a small dome of limited, or even dubious closure. This, coupled with substantial oil showings in two adjacent wells, prompted the test.

RINCON FIELD DEEP ZONE

C.C.M.O. Hobson No. C-9 well, Sec. 17, T. 3 N., R. 24 W., S.B.B. & M., drilled to 9,337 feet, well below all previous producing zones in the Rincon field. After a long history of testing and redrilling, the well had, by the end of the year, established the presence of sub-commercial quantities of oil from two zones lower than any previously penetrated in the field. In the interval from 8,818 to 9,290 feet, the well produced at various times, either flowing or on the pump, 30–160 barrels daily of 25°–26° gravity oil. Later, in the interval from 8,275–8,530 feet, the well pumped at the rate of 90–114 barrels a day, of 26° gravity oil, with 1–2 per cent cut. At the end of the year the well was still testing and gun-perforating successively higher zones. This project established a considerable thickness of saturated sands, but the permeability and porosity are inadequate to produce commercially.

At the same time, and in the same section of the field, C.C.M.O. Hobson No. C-3 well was also drilling. It penetrated to a stratigraphic depth of approximately 900 feet below that of No. C-9, eventually attaining a depth of 10,515 feet. This well experienced a history somewhat similar to its companion and was eventually redrilled to 10,075 feet. From the 1,049-foot interval in this redrilled hole (from 9,026 to 10,075 feet) the well was completed in late December, flowing initially at a rate of 51 barrels daily of 25° gravity oil, cutting 31.3 per cent.

Both wells discovered saturated zones of considerable thickness, but too tight to be commercially profitable. Their chief significance lies in the fact that they have established the presence of oil in this part of the section. Elsewhere in the general area, where permeabilities have increased sufficiently and structural conditions are suitable, production can be anticipated from this zone.

REVIEW

The outstanding event of 1941 was the discovery of oil at Raisin City and in the Helm and Riverdale fields. These successes mark the beginning of a new cycle of exploratory effort in California. In their present imperfect state of development, with their generally thin sands and bothersome intermediate waters, these fields appear neither as large as, nor do they seem to possess the characteristic continuity or thickness of zone of, many of the older fields. But in perhaps a prematurely severe estimate of their ultimate values, we should not lose sight of their deeper significance. These fields have established the presence of oil in areas hitherto viewed with apathy or disfavor because no material evidence of oil had previously existed. Regionally they occupy positions near the structural axis of the Valley. On either side of them are vast areas of undrilled terrane of superior structural elevation where regional conditions appear to favor the development of stratigraphic traps, either by virtue of textural change, or by association with unconformities. This statement applies to older beds as well as those proved oil-bearing.

Besides pushing the frontier of oil occurrence farther northward within the Miocene of the San Joaquin Valley, completion of the Helm well has given added reassurance that the Eocene can, in the proper structural setting, be expected to be productive beyond the limits of the Gatchell pool, near Coalinga.

In proved field activity, perhaps the event which may ultimately be of most significance is the initiation of development in outlining reserves adjacent to the great Elk Hills Naval Reserve.

In summary, the year's developments appear to justify the following inferences and statements.

1. The impressiveness of 1941 discoveries lies chiefly in their number—not size. No one of the new fields, with the possible exception of Riverdale, appears to be of major dimension. Barrels of actual oil discovered have been disappointingly small, amounting to perhaps one-tenth of the year's total production of 220 million barrels.

It thus appears we have expended reserves ten times faster than we have banked them.

2. The diminishing size of the fields found, even with an improved discovery rate and an occasional major discovery interspersed, requires an increasing number of wildcat wells to maintain reserves.

3. An increased number of prospect wells during 1941 resulted in an increased number of discoveries, with the implication existing that many of these latter are accounted for merely by a more thorough application of geologic thought and technique.

4. The discovery of oil in a new area, or rather an old province extended, provides grounds for expecting further discoveries of similar character. It additionally lends basis for prospecting for stratigraphic traps on either side at localities paleogeographically more favorable.

5. Cost per barrel of oil discovered may be expected to increase, not only because of reasons incident to war but for others as well.

(1) Geophysical costs will rise because of the additional detail required to find structures of the size and type currently sought. Cost of geophysical work in these areas is additionally increased: by regional conditions of poor reflection response, generally requiring closer control; by increased culture and its attendant handicaps; and by difficulties imposed by floods, slough-ways, and marshes in local areas along main stream channels.

(2) With decreasing size and number of structures of anticlinal type, the need grows for inspecting the various areas for faults or stratigraphic traps. These types of plays, particularly the latter, require more wells to satisfactorily explore them.

6. A growing need for gas, not only in its own right, but as a substitute to replace oil, will engender a more aggressive campaign in search for reserves of this material, particularly in the central and northern valley gas regions of the state.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to his associates and friends for their helpful coöperation in supplying him with such information as was required, and particularly for their needed advice and criticism. He wishes especially to mention E. H. Vallat, Albert Gregersen, E. R. Baddley, R. M. Barnes, H. W. Hoots, and E. R. Atwill.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1155-1159, 2 FIGS.

GEOLOGICAL NOTES

CORRECTION

SUTTER (MARYSVILLE) BUTTES DEVELOPMENT, SUTTER COUNTY, CALIFORNIA

The following corrections should be made in the article by Walter Stalder, "1941 Supplement to Sutter (Marysville) Buttes Development, Sutter County, California," in the *Bulletin*, Vol. 26, No. 5 (May, 1942).

Page 852, last line. Change "eventually" to *promptly*.

Page 854, second line. Change "1 million" to *3 million*.

CORRECTION

MINUTES, TWENTY-SEVENTH ANNUAL BUSINESS MEETING

In the minutes of the twenty-seventh annual business meeting of the Association, at Denver, April 22–24, 1942, as printed on page 923 of the May *Bulletin*, the war-effort resolution should have been worded as follows.

"That the American Association of Petroleum Geologists continue, through its president and the national service committee, to coöperate fully with the war effort of our country, especially for the maintenance of adequate petroleum reserves and in the placement of technically trained personnel so as best to serve the requirements of the armed forces, governmental agencies, and various branches of essential industry."

GRAPHIC METHOD FOR SOME GEOLOGIC CALCULATIONS[1]

MASON L. HILL[2]
Bakersfield, California

The accompanying D, D, D, and T graph (Fig. 1) can be used for the solution of geologic right-triangle problems. It is here applied to the solution of dip, depth, distance, and thickness of strata by simple

[1] Manuscript received, March 11, 1942.

[2] Geologist, Richfield Oil Corporation.

two-dimensional calculations. These graphical solutions can be readily and visually made without the manipulation of pencil, protractor, and scale. The form itself can be made by constructing quadrant arcs on rectangular coördinate paper with, if desired, the addition of a rotating arm for dip angles.

The graph[3] is designed to facilitate direct graphic solutions of stratigraphic problems. As a direct graphic it has advantages over those table and chart methods[4] which are based on trigonometric formulae. These advantages are the tendency to eliminate gross errors and the more consistent accuracy for all dip angles. Furthermore, the graph enables these solutions to be made as rapidly as by any other method.

Three-dimensional calculations can be made on the graph, by two or more right-triangle solutions, but other forms[5] are ordinarily better adapted to these more complicated problems.

The writer began using this method to facilitate graphic solutions a number of years ago, by adding rectangular coördinates to the Penfield arm protractor. Since then several of his associates have professed using the method to advantage. This presentation is thus made after trial, and encouragement and aid from many persons,[6] with the expectation that it will be useful to other geologists.

Figure 2 illustrates the solution of some geologic problems on the D, D, D, and T graph. These problems involve four quantities taken three at a time so that thickness, depth, distance, and dip are each found three ways as classified in the illustration.

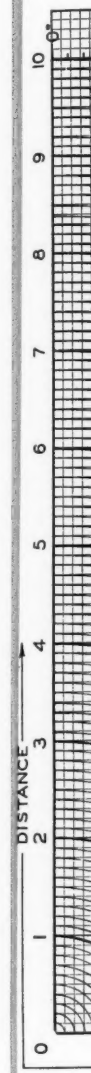
Limitations and other applications will become evident to one who uses the graph. The "three-point" determination of dip, for example, involves the solution shown in Figure 2J.

[3] A similar form is the Trigonograph, American Chemical Rubber Company, Cleveland, Ohio, copyright 1934.

[4] Frederic H. Lahee, *Field Geology*, 3d ed. (1931), pp. 729 and 731. J. B. Mertie, Jr., *U. S. Geol. Survey Prof. Paper 129C* (1922), opp. p. 50.

[5] H. S. Palmer, *U. S. Geol. Survey Prof. Paper 120G* (1918), opp. p. 128. W. S. Tangier Smith, *Econ. Geol.*, Vol. 20 (1925), pp. 181–84. J. B. Mertie, Jr., *Bull. Geol. Soc. America*, Vol. 51 (1940), pp. 1107–34.

[6] The writer is particularly indebted to Hubert G. Schenck, W. S. Tangier Smith, and A. O. Woodford.



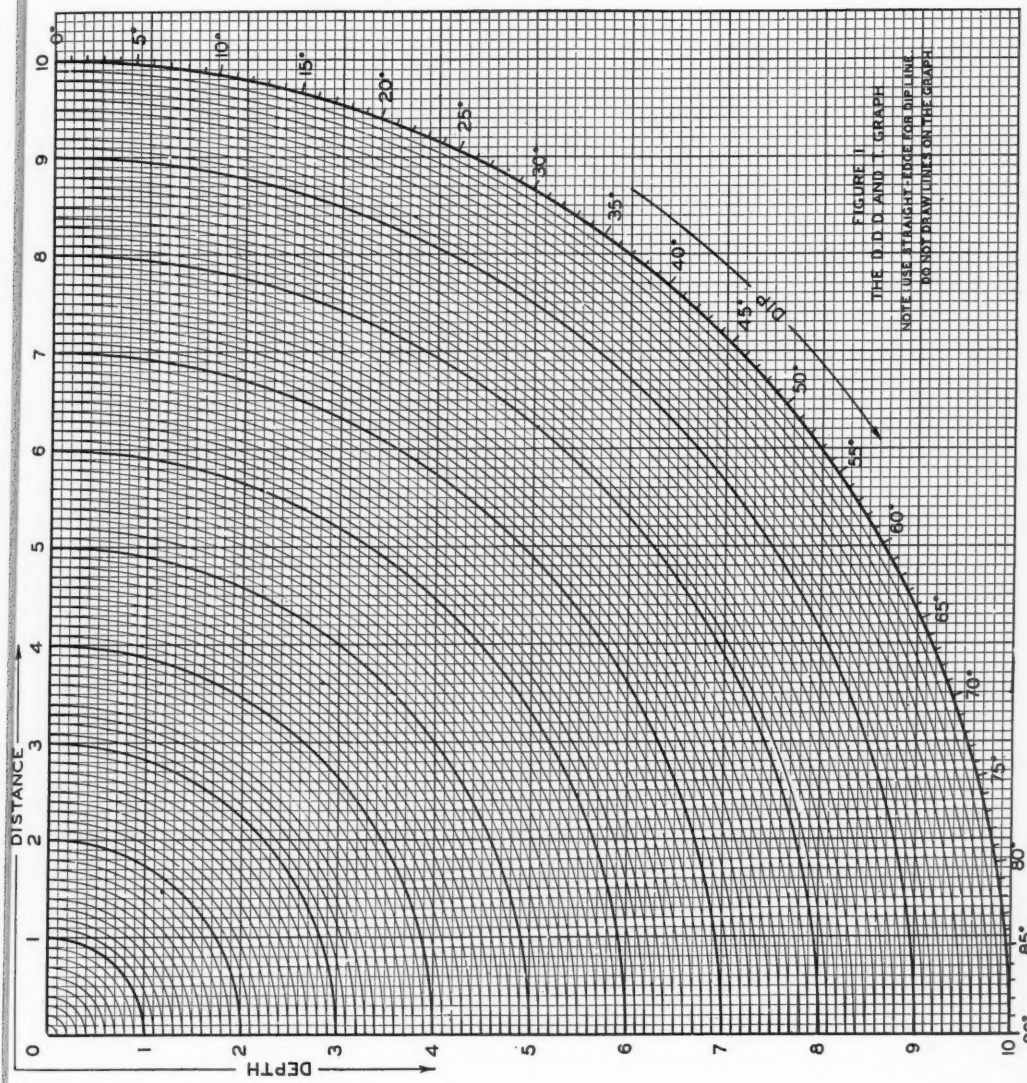
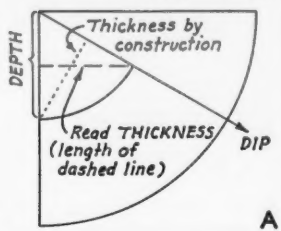
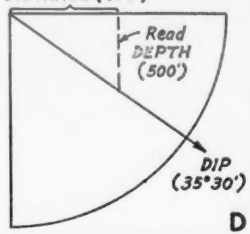
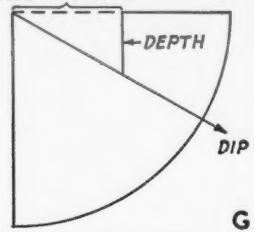
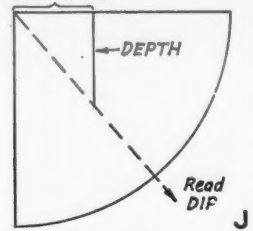
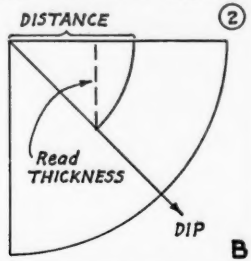
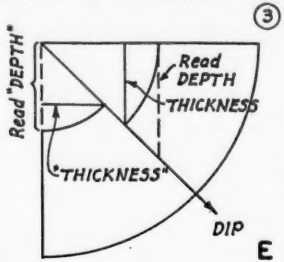
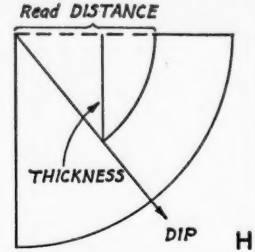
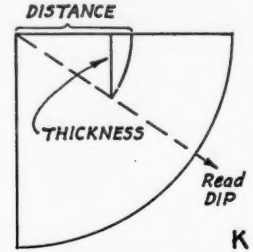
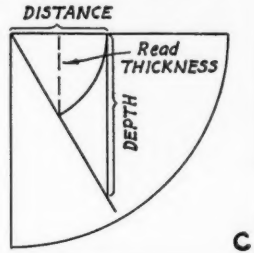
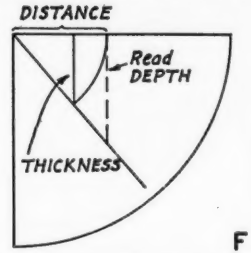
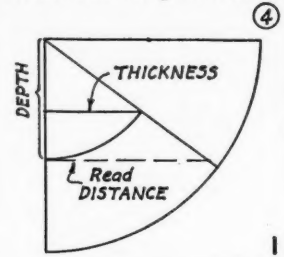
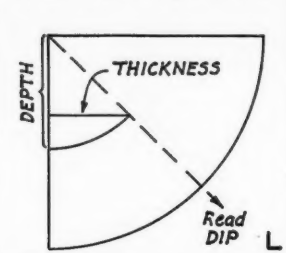

DISTANCE
DEPTH
0°
5°
10°
15°
20°
25°
30°
35°
40°
45°
50°
55°
60°
65°
70°
75°
80°
85°
90°
FIGURE 1
THE D, D AND T GRAPH
NOTE: USE STRAIGHT EDGE FOR DIP LINE
DO NOT DRAW LINES ON THE GRAPH

FIG. 1

FIGURE 2. TYPE PROBLEMS ILLUSTRATED *(see accompanying discussion)*

TO FIND THICKNESS	TO FIND DEPTH	TO FIND DISTANCE	TO FIND DIP
Given: DEPTH and DIP See note ①  	Given: DISTANCE and DIP  	Given: DEPTH and DIP  	Given: DEPTH & DISTANCE 
Given: DISTANCE and DIP ②  	Given: DIP and THICKNESS ③  	Given: DIP and THICKNESS  	Given: DISTANCE & THICK. 
Given: DISTANCE & DEPTH  	Given: DISTANCE & THICK.  	Given: DEPTH & THICK. ④  	Given: DEPTH & THICK. 

Explanatory Notes (refer by number to Figure 2)

(1) In Figure 2A the dashed line is the same length as the dotted line because they are analogous sides of equal right triangles. The dotted line is, however, thickness by construction; thus, the length of the dashed line (read directly on the graph) represents that thickness.

(2) In the solution of Figure 2B, if there is a deviation from horizontal in a surface section, or from vertical in a well section, make the obvious addition or subtraction of this angle to or from the dip and read thickness directly (for example, with a traverse up a 10° slope in the direction of a 22° dip, use a 32° dip on the graph).

(3) Two solutions are illustrated in Figure 2E because either thickness in horizontal section or "thickness" in vertical section may be known.

(4) Notice that the dip angle is actually found in Figure 2I but it is shown, according to the classification in the illustration, separately in Figure 2L.

Geologic Applications (refer by letter to Figure 2)

(A) Use this solution for the determination of stratigraphic interval in a vertical section. For example, the depth intervals between two horizons in a number of wells can be corrected for dip to give thicknesses as control for the construction of an isopach map.

(B) Use this solution for the calculation of the thickness of a surface section.

(C) This solution can be used to determine difference in stratigraphic (and structural) position between outcrop and well or between two wells.

(D-E-F) Use these solutions for the prognostication of depth difference to a given horizon between outcrop and well or between two wells or for the depth between two horizons (isochord) in the same well.

(G-H-I) These solutions can be used to determine distance necessary to obtain a given stratigraphic or structural difference between outcrop and well or between two wells. For example, the solution of Figure 2G can be used to determine the spacing of structural contours between two wells.

(J-K-L) Use for determination of dip or dip component between outcrop and well or between two wells or for calculation of dip (Fig. 2L) within a known stratigraphic interval in one well.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1160-1167

REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by asterisk are in the Association library, and available, for loan, to members and associates.

OUTLINES OF STRUCTURAL GEOLOGY
BY E. SHERBON HILLS

REVIEW BY BURTON WALLACE COLLINS[1]
Gisborne, New Zealand

Outlines of Structural Geology, by E. Sherbon Hills, lecturer in geology in the University of Melbourne. ix+172 pp., 4 pls., 105 figs. Methuen and Company Ltd., London (1940). Price, 6s. 6d.

Inside the jacket of this book the publishers state that the author's aim

> has been to present an outline of those sections of structural geology that are most likely to find practical application in the field and in the laboratory. . . . It is hoped that the book may serve both as an inexpensive textbook for students and as a convenient summary for the mature geologist. Numerous references to the literature are given throughout.

The author amplifies this in his Preface, where he writes:

> In this book, I have aimed at presenting a brief, yet reasonably complete and well-documented summary of structural geology, with special reference to those aspects of the subject with which the field geologist should be acquainted. The nomenclature of certain sections of structural geology is at present in an unsatisfactory condition, and I have therefore given as full a synonomy as appeared to be necessary for the guidance of students in wider reading, which, it is hoped the bibliographic references will facilitate.

In the reviewer's opinion the book admirably fulfills these objects and should be found very useful by a large number of geologists. It is definitely not "just another textbook," and while the author does not attempt to make any original contributions, his book supplies in small compass and at a remarkably small cost most of the essentials, within the scope of the subject, which the field geologist will be very glad to have so readily accessible. The numerous references to recently published books and papers (not only in English but also in German) are not the least valuable feature of the book. The Author Index contains 198 entries, and in many cases, of course, several works of the same author are mentioned. British, American, and European (as well as several Australian and New Zealand) authors are included. The writer, an Australian, is perhaps better able to appreciate the relative significance of the contributions of the various nationalities than an author nearer one of the major centers of geological thought, who might be led to overestimate the importance of the work of his own countrymen.

The plates and figures are clear and well chosen, many being original. Of particular interest to the reviewer (and probably to others) is the frontispiece —a photograph by M. Ongley, of the New Zealand Geological Survey, of intraformational contorted beds at Awa-awa Beach, New Zealand. Other plates illustrate structural features of rocks in Victoria (Australia) and experimentally produced faults in clay. The figures include line drawings, sections, block diagrams and maps.

[1] New Zealand Petroleum Company. Manuscript received, February 11, 1942.

The first chapter (19 pages) on "Non-Diastrophic Structures" is divided into two sections—"Primary Structures of Sedimentary Rocks" and "Non-Diastrophic Deformation." In the latter section the treatment of subaqueous slumping, sliding, and gliding is brief but adequate. These phenomena are probably the cause of many anomalous dips which have been the source of much confusion in the mapping of certain possible oil-bearing structures on the west coast of the North Island of New Zealand. Gravity-collapse structures are also dealt with, and reference made to recent work in southwest Persia which will be of interest to oil geologists.[2] An excellent figure illustrates the development of the chief types of structure—knee fold, roof and wall structure, flap, slip sheet, cascade, and flap and cascade.

The second chapter (24 pages) summarizes "The Mechanical Principles of Rock Deformation," with particular reference to the experiments of Griggs, Adams, Nicholson, Coker, Bridgman, and Cloos. The author adds the wise, if naive, comments:

> Experimental results . . . must, however, be used with caution in geology. . . . The formation of the remarkable limestone flaps in Persia . . . indicates that even in superficial crustal layers, limestone is extremely plastic under slow deformation. . . . The phenomena of relaxation in amorphous solids . . . also suggest that the geologist would be unwise to withdraw the long-held tenet that permanent strain in rocks can take place under the action of small stress differences, applied over a very long period of time.

The third chapter (25 pages) deals with "Major Crustal Structures" and describes the "chief types of crustal architecture" under the headings: nappe structures, normal folding, plains type of folding, fault-folding (*Bruchfaltung*), and block faulting. A special section on the origin of grabens reviews the various theories (with references) and includes a series of previously unpublished figures illustrating the latest theory of E. J. Wayland, which ascribes the East African rifts to deep-seated lateral compression. Recent investigation of gravity anomalies is said to support Wayland's interpretation.[3]

The three sections of the fourth chapter (35 pages) on "Folds," are: "The Geometry of Folds," "Mechanics of Formation of Individual Folds," and "Minor Structures in Folded Rocks." In his definitions of parts of folds the author in the main follows Busk,[4] but makes provision for pitching folds (a very necessary step) by restricting the term *crest* to the line joining the highest points of a fold, as defined by a particular bed. Busk's *crest* (a line at ground surface within the anticline, along which all horizons lie horizontally) is re-termed *crest line* by analogy with *axial line* (the intersection of the axial plane with either the ground surface or a horizontal plane), and re-defined as the intersection of the crestal plane with either the ground surface or a horizontal plane.

The troublesome term *axis*, which has been used by geologists in a variety

[2] J. V. Harrison and N. L. Falcon, "Collapse Structures," *Geol. Mag.*, Vol. 71 (1934), pp. 529–39.

———, "Gravity Collapse Structures and Mountain Ranges as Exemplified in Southwestern Persia," *Quar. Jour. Geol. Soc.*, Vol. 92 (1936), pp. 91–102.

S. M. Lees, "The Geology of the Oilfield Belt of Iran and Iraq," in *The Science of Petroleum* (Oxford, 1938), pp. 140–48.

[3] E. J. Wayland, "Some Account of the Geology of the Lake Albert Rift Valley," *Geogr. Jour.*, Vol. 58 (1921), pp. 344–59.

[4] H. G. Busk, *Earth Flexures: Their Geometry and Their Representation and Analysis in Geological Section with Special Reference to the Problem of Oil Finding* (Cambridge, 1929). 106 pp., 92 figs.

of senses (some of which are already covered by such terms as crest and axial line) is discussed, and the suggestion made that Dana's usage[5] be adopted (the trace of the axial plane of a fold on a transverse section across it). A term is then required only for the intersection of the axial plane with a given bed in order to complete the terminology. For this the author proposes *apex*. This term had previously been defined by Busk in the same way as Hills defines *axial line*.

> Seeing that axial line has been used for some time, at least in Australia, in the sense above indicated, it may be advisable to re-define the term *apex*, as the line along which the axial plane of a fold intersects the upper surface of any particular bed in the fold. The nomenclature herein proposed thus permits of the description of a fold with reference to each bed within it, this being often required in economic work.

It would be interesting to know how American oil geologists will receive this slightly modified but comprehensive terminology.

Various types of folds are discussed, including salt domes (with reference to the theories of Fulda and Stille, and the experiments of Escher and Keunen, Link and Nettleton) and piercement folds (*plis*, *diapirs*, *Injektivfalten*). Folds of the latter type (or closely related) occur on the east coast of the North Island of New Zealand and are apparently associated with oil seepages.

The author discusses the relations between the crestal and axial planes of parallel, similar and supratenuous folds, which are of importance to oil geologists, as the location of the crestal plane at depth affects the position of a petroleum accumulation and hence the proper position for a well.

The fifth chapter (22 pages) on "Faults" is detailed and well documented but does not depart in any important way from the usual method of treatment. The section on "Minor Structures Associated with Faults" (as also the corresponding section in the preceding chapter on "Folds") refers to many points of interest to field men.

"Structures of Igneous Rocks" is the subject of the sixth chapter (18 pages), where an excellent summary is given of the work, mainly in Europe, of Cloos and his collaborators on the tectonics of intrusions.

The final chapter (17 pages) is an eminently successful introduction to the difficult subject of "Petrofabric Analysis," probably a closed book to most petroleum geologists, but one with which any geologist should be glad to have even a nodding acquaintance.

After reading this book, the reviewer had only one regret—that the author had not extended the scope to include a chapter on the surface expression of geological structure, for as stated by Fenneman:[6]

> To whatever extent surface forms are determined by underlying structures, to the same extent structure is revealed by topographic forms. Now, topography is the first thing in evidence. . . . The form of the surface is, of course, the main thing seen [from the air], often the only thing. But the degree to which that form reflects structures is one of the surprises among recent developments.

But, after all, perhaps this phase of the subject is best left to books on geomorphology.

The book is well printed on good paper, and provided with a 9-page double-column general index in addition to the index of authors.

[5] J. D. Dana, *Manual of Geology* (New York, 1880), pp. 93, 95.

[6] N. M. Fenneman, "The Rise of Physiography," *Bull. Geol. Soc. America*, Vol. 50, No. 3 (March, 1939), pp. 349–60.

PETROLEUM GEOLOGY OF THE STATE OF SÃO PAULO, BRAZIL

(Translation into Portuguese)

REVIEW BY CHESTER W. WASHBURNE[1]
New York, N. Y.

Geologia do Petróleo do Estado de São Paulo (see heading above), by Chester W. Washburne. Translated into Portuguese, with comments and additions by Joviano Pacheco, former director-superintendent of the Departmento Geográfico e Geológico de São Paulo. XVII and 228 pp., 3 pls. (incl. geological map in colors, 1:2,000,000), 10 sketches, 125 figs. *Ministério da Agricultura, Dept. Nacional da Produção Mineral* (Rio de Janeiro, 1939).

This translation, recently received, is an improvement over my original[2] in its treatment[3] of the basal part of the Botucatú sandstone (Triassic), which Dr. Pacheco named the "Piramboia beds." Since the latter is the translator's own term, his usage should be followed. Likewise, one should use the table of carbon ratios in the translation (pp. 114–16), rather than that in the original English (pp. 142–43), which is full of typographic errors. The bibliography has been considerably enlarged.

The text of the translation is preceded (pp. XI–XVII) by an address on oil prospecting in Brazil, by Dr. Fernando Costa, now Minister of Agriculture in the national Government of Brazil.

Oppenheim's report[4] on the same region is discussed in an appendix (pp. 221–28) in Portuguese, translated from my review in this *Bulletin*.[5] There is no mention of Oppenheim's reply,[5] or of his other papers[6] on the area.

In support of my suggestion that the Paraná basin may contain oil that originated in Devonian shale, Dr. Pacheco prints (pp. 225–26) a letter in Spanish from Dr. Pablo Groeber, of the Dirección de Minas y Geologia, of the Argentine Republic, giving reasons why an origin in Devonian strata is assigned to the oil of Bolivia and to some of that in northwestern Argentina. Doubtless because of the short distance to its outcrops in the same basin, in northern Paraná, the Devonian shale may have received undue attention as a possible source of the traces of oil in the lower horizons. Now that marine Carboniferous has been reported in the southward extension of the basin in

[1] Consulting geologist, 50 Church Street. Manuscript received, March 16, 1942.

[2] C. W. Washburne, "Petroleum Geology of the State of São Paulo, Brasil," *Commissão Geog. e Geol. do Estado de São Paulo, Bol. 22*, São Paulo, Brazil, 1930. Review by H. M. Martin, *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 16, No. 4 (April, 1932), p. 426.

[3] Footnotes to pp. 41, 47, 48, 49 of the edition in Portuguese.

[4] Victor Oppenheim, "Rochas Gondwánicas e Geologia do Brasil Meridional," *Brasil, Ministerio da Agricultura, Serviço de Fomento da Produção Mineral, Bol. 5* (Rio de Janeiro, 1934).

[5] C. W. Washburne (Review of the preceding book), *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 19, No. 11 (November, 1935), pp. 1701–06. Oppenheim's reply thereto, *ibid.*, Vol. 20, No. 6 (June, 1936), pp. 819–21. Remark by Arthur Wade, *ibid.*, Vol. 20 (1936), pp. 984–85.

[6] Victor Oppenheim, "Petroleum Geology of Gondwana Rocks of Southern Brazil," *ibid.*, Vol. 19, No. 8 (August, 1935), pp. 1205–18. "Geology of Devonian Areas of Paraná Basin in Brazil," *ibid.*, Vol. 20, No. 9 (September, 1936), pp. 1208–36.

Uruguay, and even in Paraná, we may consider the Carboniferous as another possible source of the deeper oil. The strata that overlap the margins of a basin like this, may hide whole formations that occur beneath its central parts.

The most definite trace of the older oil is that which I saw in fragments of Itararé tillite from a depth of 500 meters, in a well of the Cia. Cruzeiro do Sul, northwest of Bofete. This was light green, light oil, of pleasant odor, suggestive of paraffinic kerosene. It was wholly different from that in much higher horizons, in and above the Iratý black shale, which is thick, heavy, black, asphaltic stuff, of tarry smell, mostly solid at outcrops, and nearly solid at depths of a few hundred meters. In the much older strata of the Bofete well, the light green oil thoroughly impregnates the fragments of tillite that are brought out by the bailer or cling to the drill. Films of the oil completely coat each embedded pebble. The impregnation is natural, and could not have been imitated by less than a year-long treatment, as by artificial, capillary diffusion, or by other "salting" of samples. Yet I examined the samples at the well, within a few hours of their recovery, before the drilling mud on them had time to fully dry. On cracking the chunks of tillite I observed how completely they had been penetrated by the light green oil, and the distinctive character of the latter.

Had I written these details in my book, possibly Oppenheim would not have doubted the Bofete occurrence, which he never saw. The light green oil must have had a source beneath the deposits of Gondwana glaciation, either in Devonian, in Carboniferous, or, perhaps, in other marine strata that have not yet been found beneath the formations that overlap the margins of the Paraná basin.

As in the English edition, legends are missing from three illustrations, as follows.

Under sketch No. 2, p. 32 (or p. 38 of the English edition), add this legend:

4. Glacial till, grading westward into lacustrine deposits.
3. Devonian shale, preserved where glaciers eroded less than to the east, and less than under the centers of the ice-lobes.
2. Devonian sandstone.
1. Crystalline rocks.

Under sketch No. 4, p. 76 (or p. 92 of English edition), add:

P and P′. Patagonian stresses, Upper Triassic and Permian.
A and A′. Andean stresses, Tertiary and later.
T. Resultant of A and A′, causing F-F′.
F-F′. Upthrust normal faults of the Brazilian coast.

Under sketch No. 7, p. 136 (or p. 168 of English edition), add:

Length of section: 1,300 km.

7. Basaltic lavas, Triassic or Jurassic, with local cover of terrestrial strata.
6. Botucatú sandstone, Triassic, aeolian; and the underlying Piramboia beds, Triassic, fluvio-lacustrine, with marked unconformity on 5, 4 and 1.
5. Corumbatahý shale. Upper part contains Upper Triassic marine fossils. Age of lower part unknown. Rests conformably on Permian Iratý shale, which is marine, black, persistently petroliferous, and unconformable on 4.
4. Itararé and Tatuhý formations, glacial, fluviatile and lacustrine, probably Upper Carboniferous, unconformable on 2 and 1 in São Paulo, and on 3, 2 and 1 in Paraná.
3. Ponto Grosso shale of northern Paraná. Marine Devonian, dark clay shale.

2. Basal Devonian sandstone. (Faxina sandstone of São Paulo; Furnas sandstone of Paraná.)
1. Basement complex. Archaean, Algonkian, and possibly metamorphosed early Paleozoic.

The language is good, clear Portuguese, with few rare words. The photographs are not nearly so sharp as in the English edition, and the type is smaller. The colored geological map (1:2,000,000) is missing from the copy on hand. Readers should obtain the same map on a scale of 1:1,000,000, which was reduced one-half to make the map that comes with the report, with the result that most place names on the latter can not be read without a lens.

Dr. Pacheco is to be congratulated for his translation, and thanked for his comments and additions.

RECENT PUBLICATIONS

ALABAMA

"Oligocene Foraminifera near Millry, Alabama," by J. A. Cushman and Winnie McGlamery. *U. S. Geol. Survey Prof. Paper 197-B* (March, 1942). 20 pp., 4 pls. Supt. Documents, Govt. Printing Office, Washington, D. C. Price, $0.10.

BORNEO

*"Hantkenina in the Eocene of East Borneo," by Hans E. Thalmann. *Stanford Univ. Pub., Univ. Ser., Geol. Sci.*, Vol. 3, No. 1 (Stanford University, California, April 15, 1942). 24 pp., 2 figs., 1 table. Price, $0.50.

CANADA

*"Ottawa-Bonnechere Graben and Lake Ontario Homocline," by G. Marshall Kay. *Bull. Geol. Soc. America*, Vol. 53, No. 4 (New York, April 1, 1942), pp. 585–646; 7 pls., 7 figs.

CALIFORNIA

*"Geomorphology of the Ventura Region, California," by William C. Putnam. *Bull. Geol. Soc. America*, Vol. 53, No. 5 (New York, May 1, 1942), pp. 691–754; 5 pls., 11 figs.

COLORADO

*"Possibility of Future Discoveries in Eastern Colorado," by Francis N. Bosco. *Oil and Gas Jour.*, Vol. 40, No. 49 (Tulsa, April 16, 1942), pp. 66–68; 4 figs., 1 stratigraphic column.

GENERAL

"Oil Reservoir Behavior Based on Pressure-Production Data," by H. C. Miller. *U. S. Bur. Mines R. I. 3634* (1942). Text, tables, charts.

The Rôle of Geology in the First World War, by Douglas Johnson. *Geol. Soc. America Pamphlet* (1942). 18 pp. Available *gratis* from the Society, 419 West 117th Street, New York.

*"Geology May Afford Link in Good Neighbor Policy," by Wallace E. Pratt. *Oil and Gas Jour.*, Vol. 40, No. 50 (Tulsa, April 23, 1942), pp. 44–45.

*"Theoretical and Economic Significance of Geodynamic Prospecting,"

by Sylvain J. Pirson. *World Petrol.*, Vol. 13, No. 4 (New York, April, 1942), pp. 38–41; 3 figs., 3 tables.

*"Wildcat Drilling in 1941," by Frederic H. Lahee. *Oil and Gas Jour.*, Vol. 40, No. 50 (Tulsa, April 23, 1942), pp. 48–53; 3 figs.

*"Correlation of the Silurian Formations of North America," by Charles K. Swartz *et al. Bull. Geol. Soc. America*, Vol. 53, No. 4 (New York, April 1, 1942), pp. 533–38; 1 pl.

*"Problems of Southwestern Geology," by Charles L. Baker. *Pan-Amer. Geol.*, Vol. 77, No. 3 (Des Moines, Iowa, April, 1942), pp. 161–68.

GULF COAST

"Review of the Heaving Shale Problem in the Gulf Coast Region," by Gustav Wade. *U. S. Bur. Mines R. I. 3618* (1942).

*"The Heaving Shale Problem in the Gulf Coast Region," by Gustav Wade. *Oil* (New Orleans, April, 1942), pp. 8–9, 31. First installment. Map of occurrences.

ILLINOIS

*"Geologic Distribution of Oil in the Illinois Basin," by B. F. Hake. *Oil and Gas Jour.*, Vol. 40, No. 50 (Tulsa, April 23, 1942), pp. 63–66; 4 figs., 1 stratigraphic column.

IOWA

*"Great Red Oak Fault of Iowa," by Charles Keyes. *Pan-Amer. Geol.*, Vol. 77, No. 3 (Des Moines, Iowa, April, 1942), pp. 169–75; 2 figs.

KANSAS

**Mineral Resources of Kansas.* Map by the State Geological Survey, University of Kansas, prepared under supervision of Raymond C. Moore and John C. Frye. Sheet in colors, 45×31.5 inches. Lawrence (1942). Price, $1.00.

*"Outlines of Kansas Geology, IV," by Charles Keyes. *Pan-Amer. Geol.*, Vol. 77, No. 3 (Des Moines, Iowa, April, 1942), pp. 185–224.

NEVADA

*"Stratigraphy and Structure of the Southern Ruby Mountains, Nevada," by Robert P. Sharp. *Bull. Geol. Soc. America*, Vol. 53, No. 5 (New York, May 1, 1942), pp. 647–90; 5 pls., 3 figs.

OHIO

*"Clinton Sand Drilling and Production in Central Ohio," by H. N. Ross. *Oil and Gas Jour.*, Vol. 40, No. 52 (Tulsa, May 7, 1942), pp. 55–56. Contains chart of stratigraphic column showing major units.

OKLAHOMA

*"Truncated Faulted Anticline, Oklahoma City Field, Oklahoma," compiled by *Oil and Gas Jour.*, Vol. 40, No. 52 (Tulsa, May 7, 1942). 2 pp. between pp. 56 and 57. Stratigraphic section and maps in colors.

PENNSYLVANIA

*"Spitzenberg Conglomerate as a Triassic Outlier in Pennsylvania," by Lawrence Whitcomb. *Bull. Geol. Soc. America*, Vol. 53, No. 5 (New York, May 1, 1942), pp. 755–64; 2 pls., 1 fig.

TEXAS

"The Larger Invertebrate Fossils of the Navarro Group of Texas (Exclusive of Corals and Crustaceans and Exclusive of the Fauna of the Escondido Formation)," by Lloyd W. Stephenson. *Bur. Econ. Geol. Pub. 4101* (Austin, 1941). Prepared in coöperation with the *U. S. Geol. Survey*. 641 pp., 95 pls., 13 figs. Price: paper, $3.50; cloth, $4.25.

*"Rice Sands in Polk and Adjoining Counties, with Notes on Volcanic Ash and Bentonitic Clays," by George H. Shafer. *Univ. Texas Bur. Econ. Geol. Min. Resource Survey Cir. 41* (Austin, February, 1942). 5 mim. pp. and 5 figs.

*"West Texas-New Mexico Permian Basin Presents Largest and Most Prolific Proven Undrilled Oil Reserve in United States," by H. H. King and Gilbert M. Wilson. *Oil Weekly*, Vol. 105, No. 9 (Houston, May 4, 1942), pp. 29–31. Many other data in special West Texas-New Mexico issue, including insert map of oil and gas fields in colors.

*"Massive Limestone High, Yates Field, Pecos County, Texas," compiled by *Oil and Gas Jour.*, Vol. 40, No. 50 (Tulsa, April 23, 1942). 2 pp. between pp. 48 and 49; sections and maps in colors.

*"Résumé of Geology of the South Permian Basin, Texas and New Mexico," by West Texas Geological Society Committee, Robert E. King, chairman. *Bull. Geol. Soc. America*, Vol. 53, No. 4 (New York, April 1, 1942), pp. 539–60; 2 pls.

TURKEY

*"Bituminous Shales in West Anatolia," by K. G. J. Ziegler. *Maden Tetkik ve Arama Enst. Mecmuasi*, Sene 6, Sayi 4–25 (Ankara, 1941), pp. 501–20 in Turkish, pp. 521–35 in German, 8 photographs, 4 photomicrographs, 10 figs.

*"A Preliminary Description of the Carboniferous and Devonian Fauna Discovered in the Western Taurus," by Cahide Ünsalaner. *Ibid.*, pp. 594–98 in Turkish, pp. 599–603 in English, 1 map, 3 pls. of fossils.

*"The Vertical Distribution of Hippurites in Southern Turkey," by S. W. Tromp. *Ibid.*, pp. 604–07 in Turkish, pp. 608–11 in English.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1168-1171, 2 FIGS

THE ASSOCIATION ROUND TABLE

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The Executive Committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

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(Continued on page 1184)

WEST TEXAS GEOLOGICAL SOCIETY STUDENT MERIT AWARD

The West Texas Geological Society Student Merit Award, consisting of a 2-year paid-up associate membership in the Association, has been made this year to William Frank Caver, of the Texas College of Mines, El Paso, and to Charles A. Renfroe, of the Texas Technological College, Lubbock. In addition to the award of the West Texas Geological Society, the Association presents to each honoree a copy of the latest cloth-bound volume of the A.A.P.G. *Bulletin*.

WILLIAM FRANK CAVER

CHARLES A. RENFROE

WILLIAM FRANK CAVER.—Born in Hainesville, Texas, February 15, 1921. Attended Sabine High School, Gladewater, Texas, from the fall of 1934 through the spring of 1938; Kilgore Junior College, summer of 1938; College of Marshall, school year of 1938–1939; College of Mines, El Paso, from fall of 1939 through spring of 1942. Degree: Bachelor of Arts in Geology (31 semester hours in geology). During college, worked at odd jobs to meet expenses; also, part-time work in State National Bank of El Paso. Oil-field experience: worked for Tysco Oil Company, Kilgore, Texas, switching and roustabouting, summers of 1935 and 1936; Sultana Oil Corporation, Kilgore, roughnecking and roustabouting, summer of 1939. Single. Home address: Box 187, Kilgore, Texas.

CHARLES A. RENFROE.—Born in Plainview, Texas, June 4, 1912. Attended Johnson Grade School, Amarillo, Texas, from September, 1919, to June, 1927; Amarillo High School, September, 1928, to June, 1932. Worked as field aid for Gila Pueblo archeological reconnaissance survey of Chihuahua, Mexico, from February, 1933, to July, 1933; served as assistant archeologist and paleontologist for Panhandle Plains Historical Museum at Canyon, Texas, under Floyd V. Studer. Attended Texas Technological College at Lubbock for one period from September, 1935, to June, 1936, and then left to go to work. Served as warehouse manager for General Electric Supply Company in Amarillo, Texas, as feature writer for the Globe-News Publishing Company, Amarillo, apprentice carpenter, painter, and did historical research for an artist doing murals for the Government. Texas Technological College, from September, 1939, through spring of 1942 (62 hours in geology). Member of Petroleum and Geological Engineer's Society. Married; daughter, 3 years. Home address: 2804 Twenty-Third Street, Lubbock, Texas.

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MEMORIAL

BERTRAND S. RIDGEWAY
(1899–1942)

BERTRAND S. RIDGEWAY

Bertrand S. Ridgeway was born, September 30, 1899, in Bonita, Johnson County, Kansas. He passed away unexpectedly on January 22, 1942, at Mattoon, Illinois, as the result of a heart attack. Although he had been ill for a few days shortly before, there was no indication that a critical condition had developed. He had been at his desk the previous day. He is survived by his

wife, Margaret Poland Ridgeway, whom he married, November 21, 1927; a son, Richard, aged 11; and his mother, Mrs. Mary Ridgeway, of Lawrence, Kansas.

Bert Ridgeway graduated from Paola, Kansas, High School in 1918 and attended the University of Kansas where he received his Bachelor of Arts degree in 1922, specializing in petroleum geology. He was a member of Sigma Gamma Epsilon. His affiliation with the American Association of Petroleum Geologists began in 1921 as an associate member and he advanced to active membership in 1929.

His employment as a geologist took him to Kansas, Oklahoma, Texas, Michigan, and Illinois. He also spent some time in Canada. From 1922 to 1923 he worked for the Sinclair Oil and Gas Company; 1923 to 1924, Owen-Osage Gas Company, Caney, Kansas; 1924 to 1929, the firm of Roth and Faurot, Independence, Kansas. During most of the time since 1929 he was employed by the Empire Oil and Refining Company and its successor, the Cities Service Oil Company. At the time of his death he was in charge of land and geological work for this company in the Illinois district.

The interest he took in his work, the persistence with which he carried out his assignments and the practical business sense with which he applied his knowledge of geology helped gain the success he attained. He served his employer energetically and loyally. He was a credit to the profession of petroleum geology.

The friendship he extended was refreshing because the recipient was sure of his sincerity and unselfishness. The cheery smile and firm handclasp with which he greeted one expressed his ever prevalent good nature.

The best memorial that his friends could dedicate to him would be to follow his fine philosophy of life.

HOMER H. CHARLES

BARTLESVILLE, OKLAHOMA
February 28, 1942

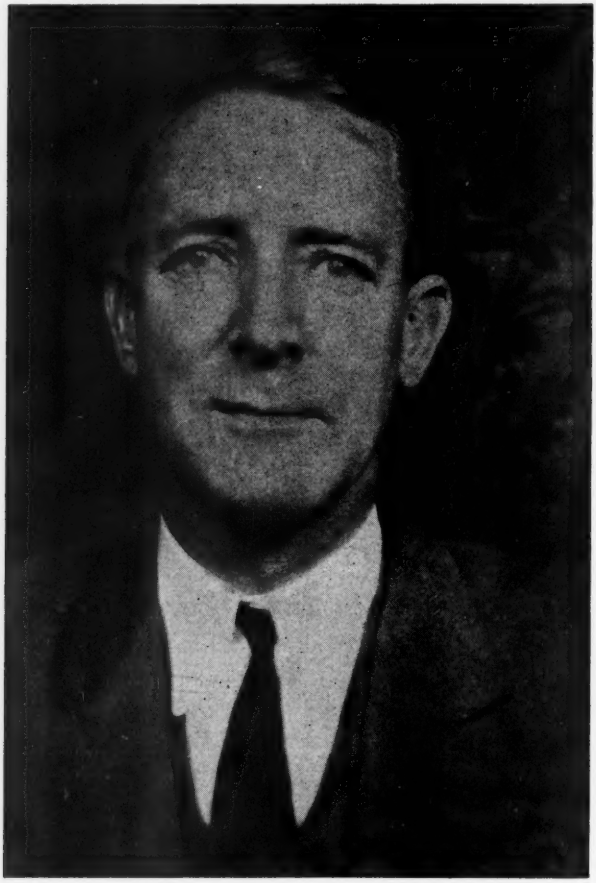
CHESTER A. HAMMILL
(1889–1941)

Chester A. Hammill was born, November 22, 1889, at Chicago, Illinois. His early years were spent in Maywood, Illinois, where he attended the public schools, following which he entered the University of Illinois as a student of mechanical engineering. After two years at Illinois, he transferred to the University of Chicago, receiving his S.B. degree in chemistry and geology in 1912, and then taking graduate work in geology and paleontology. He took an active part in extra-curricular pursuits, being a charter member of Chi chapter, Alpha Sigma Phi, a member of Blackfriars, Acacia Club, the Glee Club, and going out for track.

During the summer of 1915, Chester was geologist for the Wisconsin Geological Survey, engaged in determining the extent and value of ore deposits in the Penokee Iron Range.

In September, 1915, he joined the Roxana Petroleum Corporation as geologist and during the next four years made areal geological examinations for this company in Kansas, Oklahoma, North Texas, the Texas Gulf Coast, Louisiana, and Nebraska, and subsurface investigations in Texas.

Chester opened his office as consulting geologist in Dallas, Texas, in 1919, maintaining it until his death. During that year and 1920 he did extensive work in northwestern Louisiana and Texas, publishing his findings as an



CHESTER A. HAMMILL

article, "The Cretaceous of Northwestern Louisiana," in the *Bulletin* of the Association, Vol. 5, No. 2 (March–April, 1921), pp. 298–310.

It was also in 1920 that he made the first of his examinations in Mexico on the Isthmus of Tehuantepec, Vera Cruz. Until the Mexican Government stopped American operations, he made numerous investigations in various parts of Mexico and for several years was employed on detailed examinations

in the northeastern part of the country. His activities in the United States included examinations throughout the Southwest, especially the coastal belt of Texas, East Texas, North Texas, the Permian basin, Louisiana, Oklahoma, and Arkansas.

Chester was one of the small group of geologists who formed the Southwestern Association of Petroleum Geologists at Tulsa in 1917, which in 1918 became the American Association of Petroleum Geologists. He contributed to the success of the conventions of this organization held in Dallas in 1926 and 1934, serving on convention committees.

He also held membership in the Society of Dallas Petroleum Geologists and the American Institute of Mining and Metallurgical Engineers, and was registered with the Texas State Board of Professional Engineers.

Throughout his life Chester was active in Masonic circles and did much for Masonry both in Mexico and the United States.

During his college years he "worked his way through college," not by selling magazines, but by telegraphing for the Great Western and Illinois Central railways. His interest in telegraphy continued in later years, and at the time of his death he had accumulated a good collection of early telegraph instruments and a small library on the subject.

As a geologist and as an engineer his record speaks for itself—his honesty and integrity were unimpeachable. .

As a Mason his timely suggestions and warm friendly handclasps will long be remembered. His voluminous records are extremely accurate, and now priceless.

As a man he was unassuming, chivalrous, diligent, and generous.

Chester's death on December 7, 1941, was caused by a heart attack, after several years of ill health. He is survived by his wife, Rhoda I. Hammill, whom he married in 1915, and two daughters, Rhoda E. and Mary Helen.

SAM M. ARONSON

DALLAS, TEXAS
March, 1942

ROY J. METCALF
(1889–1941)

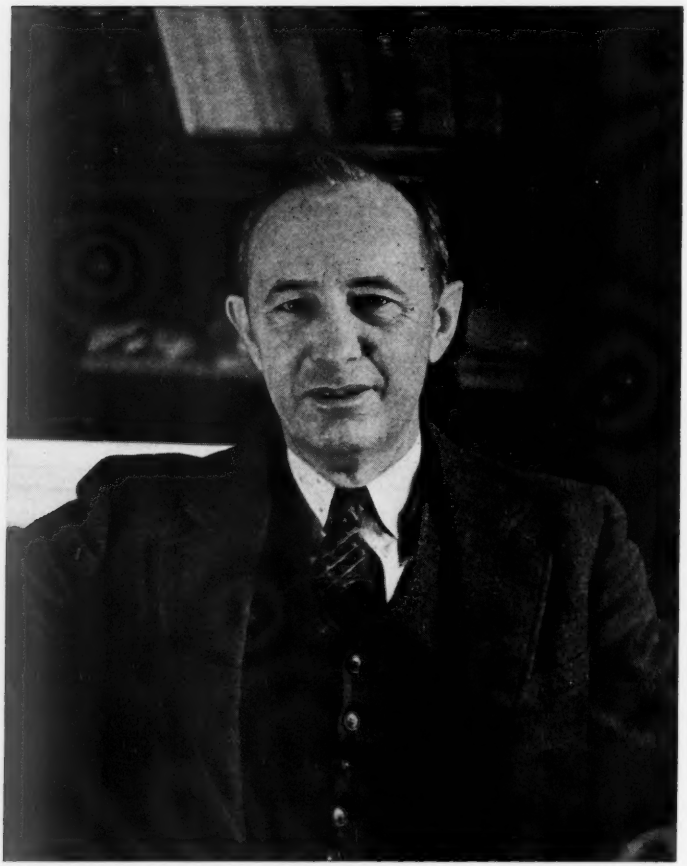
The geologic profession lost one of its most ardent followers, and The Ohio Oil Company a loyal and capable geologist, when Roy J. Metcalf passed away at Houston, Texas, on October 6, 1941. From the time he entered petroleum geology as an employee of the Indian Territory Illuminating Oil Company, April 15, 1917, until his death, he never wavered in his course. Geology was the absorbing interest in his life.

His character and success in no small part are due to his family background and the sterling character of his ancestors.

Michael Metcalf, the first of the Metcalf clan in America, came from England in 1637 and settled at Dedham, Massachusetts. Michael taught the first school to be established at that place, where he was honored by his townsmen for his intellect and his integrity.

Roy's great grandfather Metcalf was a lieutenant in the Continental army during the American revolution. The family moved from North Carolina

to Greenville, Illinois, where Roy's father, Henry Hill Metcalf, was born on May 28, 1843. Roy's father volunteered for service in the Union army at the age of seventeen and served throughout the Civil War. Following the war he



ROY J. METCALF

secured as much education as the local academy offered and became a teacher in the rural schools of Bond County, Illinois.

On September 26, 1866, Henry Hill Metcalf married Ellen Sarah Hilliard, a native of Bond County, Illinois. Her father had emigrated to Illinois from Rutland, Vermont, where his father had served in the army of his cousin, Ethan Allen, during the Revolutionary War.

Henry Hill Metcalf, with his family, went west in 1877, and settled near Fort Collins, Colorado, where Roy J. Metcalf, the tenth child in a family of eleven children, was born, July 8, 1889. When Roy was six years old the family moved to Horatio, Arkansas, where the father resumed his work as a school teacher, serving for many years as principal of the Norwoodville School.

Roy J. Metcalf secured his elementary education at Norwoodville. His first teacher, Miss Carrie Dickinson, was a college woman who for many years was a real inspiration to the youth of the community. Roy never attended high school, but being well grounded in the old-fashioned fundamentals taught by his father and Miss Dickinson, he entered the preparatory school of the University of Arkansas, and was graduated in five years with a degree of Bachelor of Science, with a major in geology, in 1913. He, like many other young men, was undecided what course of study to pursue. The inspiration and counsel of Dr. Drake, then professor of geology at the University, were responsible for Roy's decision to make geology his life's work.

Immediately following his graduation from the University, he accepted a position in the United States Government Schools in the Philippine Islands where he taught for three years, the last two of which he served as superintendent of the schools on the Island of Romblou. His mental alertness and eagerness for knowledge, displayed constantly throughout his professional life, were manifest early, as evidenced by the fact that while in the East he spent his vacations in China and Japan, making the most of his opportunity to acquire first-hand knowledge of these countries.

Still thirsting for a better foundation and background in his chosen profession, he entered the graduate school of geology of the University of Chicago upon his return from the East in 1916, with the intention of securing a master's degree in geology for the purpose of teaching in this field. After several months, however, he gave up the idea of teaching, and on April 15, 1917, he accepted employment in the geological department of the Indian Territory Illuminating Oil Company at Bartlesville, Oklahoma.

On October 5, 1917, he enlisted in the United States army; was made a sergeant on June 8, 1918; and was commissioned Second Lieutenant on August 18, 1918.

August 29, 1918, he married Nina Lydia Hamilton at Fayetteville, Arkansas. Their only son, Hugh Edward Metcalf, was born at Fayetteville, October 4, 1919.

Roy received his honorable discharge from the army in 1919 and returned to employment with the Indian Territory Illuminating Oil Company, where he remained until February 28, 1926. Most of his efforts with the Indian Territory Illuminating Oil Company were in field geology in Oklahoma. He spent much time in what is now the greater Seminole oil-producing province, doing reconnaissance and detailed surface geology. Even in this early period of his professional career he showed ability to recognize the significance of field observations. He was an excellent reconnaissance geologist, and with his broader outlook he was able to fill in the necessary details with skill and dispatch. He was directly responsible for the location of the Indian Territory Illuminating Oil Company's discovery well that opened the Seminole field and started the development that resulted in one of the richest oil-producing areas in the United States.

He resigned his position with the Indian Territory Illuminating Oil

Company and accepted a position as division geologist under Ray V. Hennen, chief geologist for the Transcontinental Oil Company in February, 1926. He held this position and exercised direct supervision over the geologic work in Texas, Louisiana, New Mexico, and Colorado until August, 1930. He was located in Fort Worth, Texas, where subsurface studies were carried on under his supervision. In the field he supervised the work of several surface plane-table parties and was well liked by the men under him as well as by those who employed him and worked with him. Ray V. Hennen says of him that his sterling qualities, both as a geologist and as a man, were recognized by all who knew him well. He further says, "I made frequent long trips with Roy in the field, checking up the work of the parties under him, and always looked forward to these trips. He was a little slow to get acquainted with, but once you did so, you found a real friend, and I found he had exceptional ability in his chosen profession, and in addition to that was a very hard and conscientious worker, ever keeping in mind the best interests of the company employing him."

He was elected to membership in the Association in 1926.

In August, 1930, the Transcontinental Oil Company was merged with The Ohio Oil Company and Roy was employed as district geologist by the latter company with headquarters at Fort Worth, Texas.

In October, 1931, he was sent to make a reconnaissance study of the oil possibilities of Cuba. After several months there he submitted a comprehensive reconnaissance report on the geology of that island.

In January, 1934, he was transferred to San Antonio as district geologist to study the surface and subsurface geology of that province. In January, 1936, he was sent to Houston as district geologist to cover the Gulf Coast of Texas and Louisiana, in which capacity he was serving at the time of his death. As time went on, those who came in contact with him and his work realized more and more his keen insight into geologic problems and processes and his sterling character and steadfastness of purpose and loyalty to his employer, his friends, and his profession.

He was quiet and retiring by nature but held steadfastly to his well formulated geologic opinions despite the fact that others may have entertained different views.

He was a real friend, a kind father, and a devoted husband. He will be sorely missed by his family, his friends, and his colleagues.

He is survived by his wife, Nina Lydia Metcalf, a son, Hugh E. Metcalf, both of San Antonio, Texas; one sister, Mrs. Nellie Hill of Horatio, Arkansas, who is an honor graduate of the University of Arkansas, and now holds the position of superintendent of schools of Horatio, Arkansas; three brothers, Clyde H. Metcalf, Lieutenant Colonel in the Marine Corps, and recently made Chief of Staff at Quantico, Virginia, Jerry Metcalf, a lumberman in the state of Washington, and Harry Metcalf, of Oklahoma.

His devotion and loyalty to his employers gave little time to publish the results of his geologic study and conclusions, but his article, "Deposition of Lissie and Beaumont Formations of Gulf Coast of Texas," bears witness of his interest in and his comprehension of the problems of deposition. He thoroughly believed that the occurrence of oil was related to the history and environment of deposition. He was also co-author with Ray V. Hennen on a paper on the Yates field, Pecos County, Texas.

Grateful thanks are extended for all assistance rendered in compiling the subject matter here presented, and especially to Mrs. Nellie Hill, W. C. McMahan, Nina Metcalf, and Ray V. Hennen.

BIBLIOGRAPHY OF ROY J. METCALF

1929—"Yates Oil Pool, Pecos County, Texas" (with Ray V. Hennen), *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 13, No. 12, pp. 1509–48.
1940—"Deposition of Lissie and Beaumont Formations of Gulf Coast of Texas," *ibid.*, Vol. 24, No. 4, pp. 693–700.

FRANK RINKER CLARK

TULSA, OKLAHOMA
April 6, 1942

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 6 (JUNE, 1942), PP. 1180-1184

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

FRITZ L. AURIN, president of the Association, recently addressed local geological societies at Dallas, Houston, and Midland, Texas, Wichita, Kansas, Oklahoma City, Oklahoma, and Lake Charles, Louisiana, on Association affairs.

E. V. MCCOLLUM, of the Mott-Smith Corporation, talked before the Houston Geological Society, April 30, on "The Gravity Expression of the Hatchetigbee Anticline and the Jackson Fault Area of Alabama."

TAYLOR COLE, of the Office of University Lands, Midland, Texas, spoke on "Pre-Permian Stratigraphy and Oil Possibilities," before the Tulsa Geological Society, May 11.

Out-of-print publications of the Association are available on microfilm at Southwestern Microfilm, Inc., 709 Santa Fe Building, Dallas, Texas, as follows.

Title	*Date of Publication*	*Exposures*	*Film Price*
1. Geology of Salt Dome Oil Fields	1926	438	$ 6.38
2. Theory of Continental Drift	1928	126	2.39
3. Structure of Typical American Oil Fields. Vol. I	1929	272	4.60
4. Structure of Typical American Oil Fields. Vol. II	1929	415	6.15
5. Stratigraphy of Plains of Southern Alberta	1931	92	1.84
6. Geology of California	1933	207	3.61
7. Problems of Petroleum Geology	1934	549	7.49
8. Structural Evolution of Southern California	1936	111	2.17
			$34.63

The officers of the Alberta Society of Petroleum Geologists are: president, J. O. GALLOWAY, Standard Oil Company of British Columbia; vice-president, W. C. HOWELLS, McColl-Frontenac Oil Company, Ltd.; business manager, J. C. SPROULE, Imperial Oil Limited; secretary-treasurer, D. B. LAYER, McColl-Frontenac Oil Company, Ltd., Calgary, Alberta, Canada.

VIRGIL PETTIGREW, of the Humble Oil and Refining Company, Wichita Falls, Texas, is chairman of the war effort committee of the North Texas Geological Society.

MASON G. WALTERS, formerly with the North Penn Gas Company is now superintendent of the Jefferson County Gas Company at Sigel, Pennsylvania.

HUGH M. ELEY, recently with the Magnolia Petroleum Company, died at Dallas, Texas, May 10.

C. E. NEEDHAM has resigned as president of the New Mexico School of Mines, and director of the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico, and has accepted a position as senior mineral economist in the economics and statistics branch of the United States Bureau of Mines, Washington, D. C.

A. H. SUTTON, of the department of geology and geography, University of Illinois, has been granted leave of absence to accept a position with the Aluminum Company of America as geologist in the fluorspar district of southern Illinois and western Kentucky. His address is Aluminum Ore Company, Rosiclare, Illinois.

B. COLEMAN RENICK, recently in consulting work in San Antonio, Texas, and Mount Vernon, Illinois, is a major in the Army Air Force.

W. EVERETT SHERBONDY is a junior topographic engineer (photogrammetric) in the topographic branch of the United States Geological Survey. His address is 1403 North Hartford Street, Arlington, Virginia.

HAROLD F. MOSES, chief geologist of the Carter Oil Company, Tulsa, Oklahoma, has been elected a director in the company.

R. S. POWELL is acting division geologist in the Oklahoma-Kansas-Illinois division of The Texas Company at Tulsa, Oklahoma.

C. E. BURBRIDGE, JR. is manager of the Mexico City office of Cia. Minera de Peñoles, S.A., and Cia. Metalurgica de Peñoles, S.A., Apartado 686, Mexico, D.F.

MARGARET A. TRIBBLE has resigned from the Phillips Petroleum Company at Bartlesville, Oklahoma, to accept a position as junior geologist with the Republic Natural Gas Company at Corpus Christi, Texas.

M. G. GULLEY, of the Gulf Oil Corporation, Pittsburgh, is the new chairman of the American Petroleum Institute Division of Production, Eastern District.

HARRY H. NOWLAN, for several years with the North Central Oil Corporation at Evansville, Indiana, announces that his services are available for reports, examinations, appraisals, and estimates of reserves. As a consulting geologist and engineer, he has opened an office at 317 Court Building, Evansville.

J. WILLIS STOVALL, of the University of Oklahoma at Norman, discussed the "Mesozoic of Western Oklahoma," before the Tulsa Geological Society, May 28.

DOROTHY BAUMEISTER is on the geological staff of the Skelly Oil Company at Wichita, Kansas.

ALBERT S. CLINKSCALES, consulting geologist of Oklahoma City, is a major in the Air Corps.

J. E. EATON, consultant, Los Angeles, is a major in the Air Corps.

DON ALLEN, recently with the Signal Oil Company, is now with the Westgate-Greenland Oil Company, Union National Bank Building, Wichita, Kansas.

W. T. HUDSON, of the Richmond Petroleum Company of Colombia, for the past two years, has returned to the United States. His address is 4308 Overhill Drive, Dallas, Texas.

JOHN C. MAXWELL, recently at Princeton University, is with the Sun Oil Company at Beaumont, Texas.

CHARLES ROLLIN KEYES, age 77, editor and publisher of the *Pan American Geologist*, died at Tucson, Arizona, May 18.

J. L. STRATTON is temporarily stationed at Palestine, Texas, working for the University of Texas Bureau of Economic Geology.

J. E. EATON, consulting geologist of Los Angeles, California, has been appointed a major in the Army Air Force and ordered to duty at the Interceptor Command School, Orlando, Florida.

WILLIAM C. MCGLOTHLIN, age 47, geologist and independent oil operator, died at Corsicana, Texas, June 1, after a long illness.

J. BASIL PRESTON, of Glasgow, Kentucky, is stationed at Fort Knox, taking basic training.

C. W. COUSER, recently with the Carter Oil Company at Seminole, Oklahoma, is a lieutenant in the Air Corps. His address is 3916 North Fifteenth Street, Apartment 3, Arlington, Virginia.

J. C. POLLARD resigned his position as assistant director of geophysics with the Magnolia Petroleum Company, effective May 25, to become associated with Robert H. Ray, Inc., and Rogers-Ray, Inc., in geophysical contracting and consulting work, with headquarters in the Gulf Building, Houston, Texas.

PAUL E. NASH, who has been in the geological and geophysical department of the Socony-Vacuum Oil Company and the Magnolia Petroleum Company since 1926, became assistant director of geophysics for the Magnolia, effective May 25.

CHESTER R. PELTO, who severed his connections with The Texas Company in order to get the Master degree in geology, has finished his work at Pennsylvania State University and is now assistant professor of geology at the Georgia School of Technology.

IMPORTANT

It is important that A.A.P.G. headquarters, Box 979, Tulsa, Oklahoma, be kept informed as follows.

1. Draft classification of registrants above 35 years.

2. Changes in draft classification of members who have sent questionnaires to A.A.P.G., and any future changes in draft classification of all age groups.

3. Receipt of notice from draft board for induction into service.

4. If inducted into service, give location and branch of service, indicating type of basic training.

5. Enlisted men should furnish address and branch of service and type of training.

6. All affiliated societies of the A.A.P.G. should bring this to the attention of their local members.

UNITED STATES CIVIL SERVICE COMMISSION

Amendment to Announcement No. 133 of 1941 (Unassembled), closing receipt of applications from men and extending the period for receipt of applications from women for

TECHNICAL AND SCIENTIFIC AID, $1,440 TO $2,000 A YEAR

Amends Supplement to Issue No. 14 of Form 2279

The United States Civil Service Commission hereby gives notice that the closing date for receipt of applications from men for Technical and Scientific Aid, all grades and options, under Announcement No. 133, will be June 1, 1942. The Commission will continue to receive applications from women for these positions until the needs of the service have been met. *All applications must be filed with the Commission's Washington, D. C. office.*

A previous amendment (issued March 30, 1942) changed the first paragraph under RECENCY to read as follows:

"In filling vacancies, those eligibles will be considered first who show that they have had at least 1 year of the required education or experience within the 5 years immediately preceding the date of receipt of application."

There is an urgent need for female eligibles, qualified under the terms of this announcement, who have completed 2 years of college education with courses in mathematics. Numerous vacancies in Washington, D. C., and in the field, will be filled.

This amendment incorporates and supersedes the previous amendment. Complete information is contained in the original announcement.

Issued: May 18, 1942

ADDITIONAL MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

(Continued from page 1168)

FOR ACTIVE MEMBERSHIP

Robert James Adams, Bartlesville, Okla.
Vincent Miller, A. J. Hintze, W. H. Courtier
Maurice Hubert Stucley Barker, Point Fortin, Trinidad, B.W.I.
S. T. Waite, L. Kehrer, H. G. Kugler
Stanley A. Carlson, Bakersfield, Calif.
H. W. Hoots, Rollin Eckis, Mason L. Hill
Raymond W. Dudley, Fort Worth, Tex.
R. W. Harris, Maria Spencer, F. A. Melton
Willis Pritchard Hancock, Calgary, Alta., Canada
Theo. A. Link, J. C. Sproule, W. C. Howells
Paul Ashton Harper, Wichita, Kan.
R. L. Kidd, J. L. Garlough, L. C. Snider
James Donald Macgregor, Barranca-Bermeja, Colombia, S. A.
Theo. A. Link, C. G. Lalicker, V. E. Monnett
Robert Louis McCormick, Sinton, Tex.
J. L. Tatum, J. Garst, C. O. Fletcher
Arthur William Nauss, Calgary, Alta., Canada
J. C. Sproule, Theo. A. Link, Hubert H. Schenck
Hallowell Charles Hermann Thomas, Pointe-a-Pierre, Trinidad, B.W.I.
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Russell H. Volk, Denver, Colo.
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David Taylor Richards, Throckmorton, Tex.
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Will Silva, Barranquilla, Colombia, S. A.
W. C. Hatfield, Donald McArthur, John W. Butler, Jr.
John Hanor Webb, Evansville, Ind.
M. W. Fuller, Kendall E. Born, V. E. Monnett

FOR TRANSFER TO ACTIVE MEMBERSHIP

Frank Joseph Stangl, Houston, Tex.
R. B. Mitchell, Gentry Kidd, Shirley L. Mason
Francis Lowry Wadsworth, Bakersfield, Calif.
E. L. DeMaris, H. D. Hobson, James C. Kimble

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1006 U. S. National Bank Building

Dinner meetings, first and third Mondays of each month, 6:15 P.M., Auditorium Hotel.

ILLINOIS

ILLINOIS GEOLOGICAL SOCIETY

President - - - - - - - - - C. B. Anderson
Gulf Refining Company, Box 482, Mattoon

Vice-President - - - - - - - Darsie A. Green
The Pure Oil Company, Box 311, Olney

Secretary-Treasurer - - - - - - V. C. Scott
The Texas Company, Box 476, Mattoon

Meetings will be announced.

INDIANA-KENTUCKY

INDIANA-KENTUCKY GEOLOGICAL SOCIETY

President - - - - - - - - Edmund T. Benson
Tide Water Associated Oil Company
Evansville, Indiana

Vice-President - - - - - - - - R. R. Munoz
Terrace Oil Company, Evansville, Indiana

Secretary-Treasurer - - - - Edward J. Combs
Sun Oil Company
Evansville, Indiana

Meetings will be announced.

KANSAS

KANSAS GEOLOGICAL SOCIETY
WICHITA, KANSAS

President - - - - - - - - - George D. Putnam
Lario Oil and Gas Company
Vice-President - - - - - - - William C. Imbt
Stanolind Oil and Gas Company
Secretary-Treasurer - - - - - - Z. E. Stucky
Cities Service Oil Company
Manager of Well Log Bureau - Harvel E. White

Regular Meetings: 7:30 P.M., Geological Room, University of Wichita, first Tuesday of each month. Visitors cordially welcomed.

The Society sponsors the Kansas Well Log Bureau which is located at 412 Union National Bank Building.

LOUISIANA

THE SHREVEPORT GEOLOGICAL SOCIETY
SHREVEPORT, LOUISIANA

President - - - - - - - - - James D. Aimer
Arkansas Fuel Oil Company

Vice-President - - - - - - - Joseph Purzer
Phillips Petroleum Company

Secretary-Treasurer - - - - Van D. Robinson
Atlantic Refining Company, 1001 City Bank Bldg.

Meets the first Monday of every month, October to May, inclusive, 7:30 P.M., Civil Courts Room, Caddo Parish Court House. Special dinner meetings by announcement.

SOUTH LOUISIANA GEOLOGICAL SOCIETY
LAKE CHARLES, LOUISIANA

President - - - - - - - - - - Harry Kilian
Union Sulphur Company, Sulphur, La.
Vice-President - - - - - - - - Coe S. Mills
Ohio Oil Company, Lafayette, La.
Secretary - - - - - - - - - - Roy A. Payne
Gulf Refining Company, Lake Charles, La.
Treasurer - - - - - - - - George N. May
Union Sulphur Co., Sulphur, La.

Meetings: Luncheon 1st Wednesday at Noon (12:00) and business meeting third Tuesday of each month at 7.00 P.M. at the Majestic Hotel. Visiting geologists are welcome.

MICHIGAN

MICHIGAN GEOLOGICAL SOCIETY

President - - - - - - - - - Lee C. Lamar
Carter Oil Company, Mt. Pleasant

Vice-President - - - - - - - - A. J. Eardley
University of Michigan, Ann Arbor

Secretary-Treasurer - - - Edward J. Baltrusaitis
Box 811, Saginaw

Business Manager - - - - Gordon H. Pringle
Ohio Oil Company, Mt. Pleasant

Meetings: Second Wednesday of month at 6:30 P.M., from November to April. Informal dinner followed by discussions. Meetings held in rotation, at Lansing, Mt. Pleasant, Ann Arbor, Grand Rapids. Visiting geologists are welcome.

MISSISSIPPI

MISSISSIPPI GEOLOGICAL SOCIETY
JACKSON, MISSISSIPPI

President - - - - - - - - - Tom McGlothlin
Gulf Refining Company, Box 1105

Vice-President - - - - - - - David C. Harrell
Carter Oil Company, Box 1490

Secretary-Treasurer - - - - - - A. A. Holston
Stanolind Oil and Gas Company, Box 689

Meetings: First and third Wednesdays of each month ,from October to May, inclusive, at 7:30 P.M., Edwards Hotel, Jackson, Mississippi. Visiting geologists welcome to all meetings.

OKLAHOMA

ARDMORE GEOLOGICAL SOCIETY
ARDMORE, OKLAHOMA

President - - - - - - - - - Paul L. Bartram
Phillips Petroleum Company

Vice-President - - - George C. Hollingsworth
Independent Producer

Secretary-Treasurer - - - - - - Frank Neighbor
Sinclair Prairie Oil Company

Asst. Secretary-Treasurer - - - C. E. Hannum
The Texas Company

Dinner meetings will be held at 7:00 P.M. on the first Wednesday of every month from October to May, inclusive, at the Ardmore Hotel.

OKLAHOMA CITY GEOLOGICAL SOCIETY
OKLAHOMA CITY, OKLAHOMA

President - - - - - - - - - Richard W. Camp
Consolidated Gas Utilities Corporation
Braniff Building, Box 1439

Vice-President - - - - - - - Dean A. McGee
Kerlyn Oil Company, 2009 First Natl. Bldg.

Secretary-Treasurer - - - - - - H. T. Brown
Cities Service Oil Company, Box 4577

Meetings: Technical program each month, subject to call by Program Committee, Oklahoma City University, 24th Street and Blackwelder. Luncheons: Every Thursday at 12:00 Noon, Skirvin Hotel Coffee Shop.

SHAWNEE GEOLOGICAL SOCIETY
SHAWNEE, OKLAHOMA

President - - - - - - - Robert L. Cassingham
Amerada Petroleum Corporation

Vice-President - - - - - - - - U. R. Laves
Consulting Geologist, 723 S. Broadway, Ada, Okla.

Secretary-Treasurer - - - - - Martyna Garrison
Amerada Petroleum Corporation

Meets the fourth Monday of each month at 8:00 P.M., at the Aldridge Hotel. Visiting geologists welcome.

THE STRATIGRAPHIC SOCIETY OF TULSA
TULSA, OKLAHOMA

President - - - - - - - - - Ralph A. Brant
Atlantic Refining Company, Beacon Building

Vice-President - - - - - - Kilburn E. Adams
The Texas Company

Secretary-Treasurer - - - - Charles W. Lane
The Pure Oil Company, Box 271

Meetings: Second and fourth Wednesdays, each month, from October to May, inclusive, at 8:00 P.M.

TULSA GEOLOGICAL SOCIETY
TULSA, OKLAHOMA

President - - - - - - - - Glenn Scott Dillé
Consulting Geologist, Atlas Life Building

1st Vice-President - - - - - Maurice R. Teis
The Ohio Oil Company

2nd Vice-President - - - - Myron C. Kiess
The Pure Oil Company

Secretary-Treasurer - - - Louis H. Desjardins
Seismograph Service Corp., Kennedy Bldg.

Editor - - - - - - - - Constance Leatherock
Tide Water Associated Oil Company

Meetings: First and third Mondays, each month, from October to May, inclusive, at 8:00 P.M., University of Tulsa, Kendall Hall Auditorium. Luncheons: Every Thursday (October-May), Michaelis Cafeteria, 507 South Boulder Avenue.

TEXAS

DALLAS PETROLEUM GEOLOGISTS
DALLAS, TEXAS

President - - - - - - - - - J. A. Lewis
Core Laboratories, Inc., Santa Fe Building

Vice-President - - - - - - - C. C. Albritton
Southern Methodist University

Secretary-Treasurer - - - - - Barney Fisher
Coronado Corporation

Executive Committee - - - - Fred A. Joekel
Magnolia Petroleum Company, Box 900

Meetings: Regular luncheons, first Monday of each month, 12:15 noon, Petroleum Club, Adolphus Hotel. Special night meetings by announcement.

TEXAS

EAST TEXAS GEOLOGICAL SOCIETY

TYLER, TEXAS

President - - - - - - - - C. I. Alexander
Magnolia Petroleum Company, Box 780

Vice-President - - - - - - - E. B. Wilson
Sun Oil Company, Box 807

Secretary-Treasurer - - - - Laurence Brundall
Shell Oil Company, Inc., Box 2037

Meetings: Monthly and by call.
Luncheons: Every Monday at 12:00 noon, Blackstone Hotel.

FORT WORTH GEOLOGICAL SOCIETY

FORT WORTH, TEXAS

President - - - - - - - - - - J. B. Lovejoy
Gulf Oil Corporation

Vice-President - - - - - - Karl A. Mygdal
The Pure Oil Company

Secretary-Treasurer - - - Richard H. Schweers
The Texas Company

Meetings: Luncheon at noon, Worth Hotel, every Monday. Special meetings called by executive committee. Visiting geologists are welcome to all meetings.

HOUSTON GEOLOGICAL SOCIETY

HOUSTON, TEXAS

President - - - - - - Carleton D. Speed, Jr.
Consulting Geologist, Second National Bank Bldg.
Vice-President - - - - - - Donald M. Davis
Pure Oil Company
Secretary - - - - - - - - Wayne Z. Burkhead
Union Oil Company of California
1134 Commercial Building
Treasurer - - - - - - James W. Kisling, Jr.
Amerada Petroleum Corporation, Esperson Bldg.

Regular meeting held every Thursday at noon (12 o'clock), Mezzanine floor, Texas State Hotel. For any particulars pertaining to the meetings write or call the secretary.

NORTH TEXAS GEOLOGICAL SOCIETY

WICHITA FALLS, TEXAS

President - - - - - - - - - - Robert Roth
Humble Oil and Refining Company

Vice-President - - - - - - - - F. E. Melott
Deep Rock Oil Company

Secretary-Treasurer - - - - - Dolphe E. Simic
Cities Service Oil Company

Luncheons and evening programs will be announced.

SOUTH TEXAS GEOLOGICAL SOCIETY

SAN ANTONIO AND CORPUS CHRISTI TEXAS

President - - - - - - - - W. W. Hammond
Magnolia Petroleum Company, 1709 Alamo National Building, San Antonio
Vice-President - - - - - - - - J. M. Hancock
Southern Minerals Corporation, Corpus Christi
Secretary-Treasurer - - - - - Wm. H. Curry
Wellington Oil Company, 1108 South Texas Bank Building, San Antonio

Meetings: Third Friday of each month alternately in San Antonio and Corpus Christi. Luncheon every Monday noon at Milam Cafeteria, San Antonio, and at Plaza Hotel, Corpus Christi.

WEST TEXAS GEOLOGICAL SOCIETY

MIDLAND, TEXAS

President - - - - - - - - Ronald K. DeFord
Argo Oil Corporation

Vice-President - - - - - - Walter G. Moxey
Stanolind Oil and Gas Company

Secretary-Treasurer - - - - W. Lloyd Haseltine
Magnolia Petroleum Company

Meetings will be announced

WEST VIRGINIA

THE APPALACHIAN GEOLOGICAL SOCIETY

CHARLESTON, WEST VIRGINIA
P.O. Box 1435

President - - - - - - - - Charles Brewer, Jr.
Godfrey L. Cabot, Inc., Box 348
Vice-President - - - - - - - - H. J. Wagner
Public Service Commission
Secretary-Treasurer - - - - - - - R. S. Hyde
West Virginia Gas Corporation
Box 404, Charleston, W.Va.
Editor - - - - - - - - - Robert C. Lafferty
Owens, Libbey-Owens Gas Department
Box 1375, Charleston, W.Va.

Meetings: Second Monday, each month, except June, July, and August, at 6:30 P.M., Kanawha Hotel.

THE SOCIETY OF EXPLORATION GEOPHYSICISTS

President - - - - - - - - - Frank Goldstone
Shell Oil Company, Inc., Houston, Texas

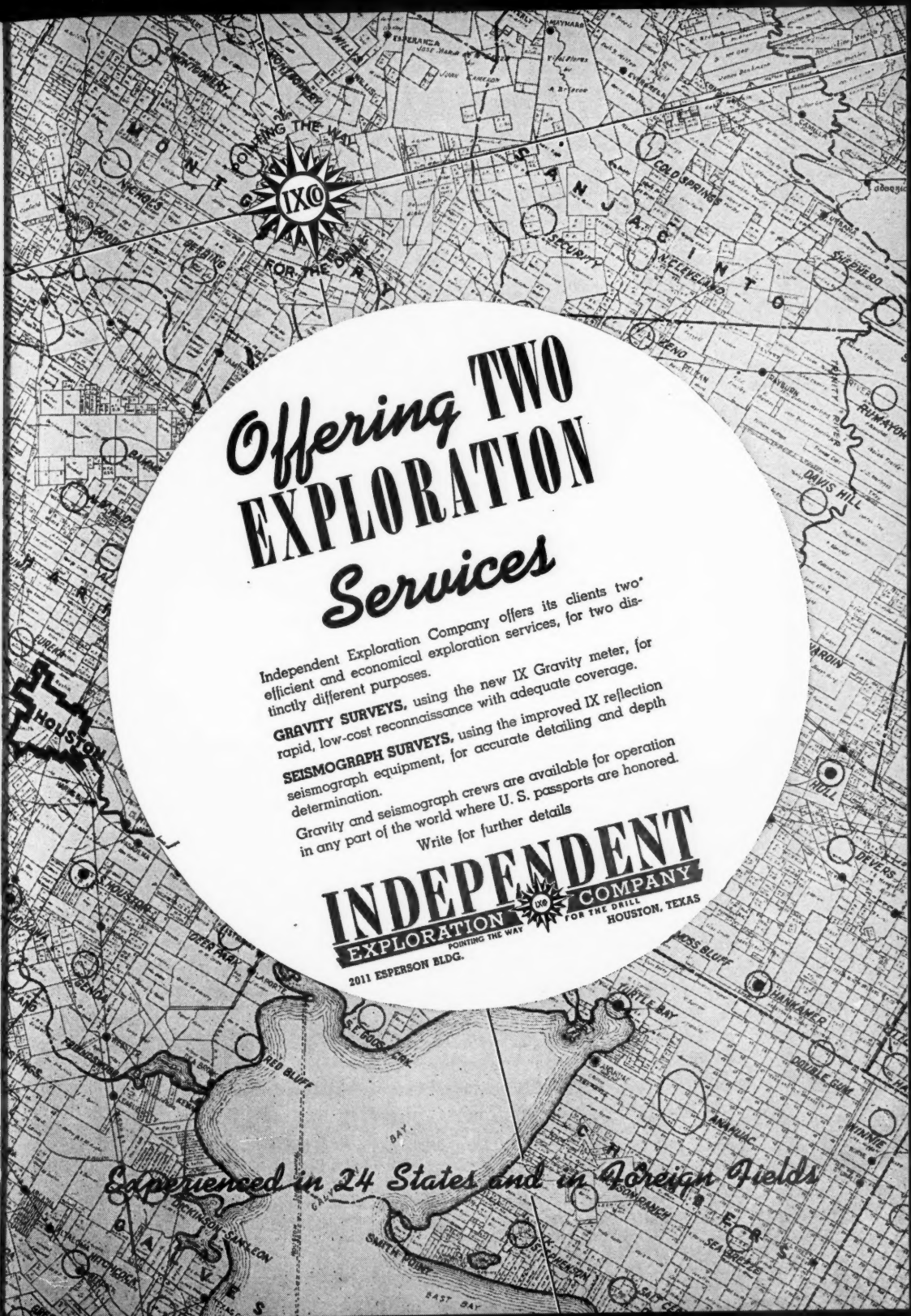
Vice-President - - - - - - - - R. D. Wyckoff
Gulf Research and Development Company
Pittsburgh, Pennsylvania

Editor - - - - - - - - - - - J. A. Sharpe
Stanolind Oil and Gas Company, Tulsa, Oklahoma

Secretary-Treasurer - - - - - - T. I. Harkins
Independent Exploration Company, Houston, Texas

Past-President - - - - - - - - H. B. Peacock
Geophysical Service, Inc., Houston, Texas

Business Manager - - - - - - - J. F. Gallie
P.O. Box 2585, Houston, Texas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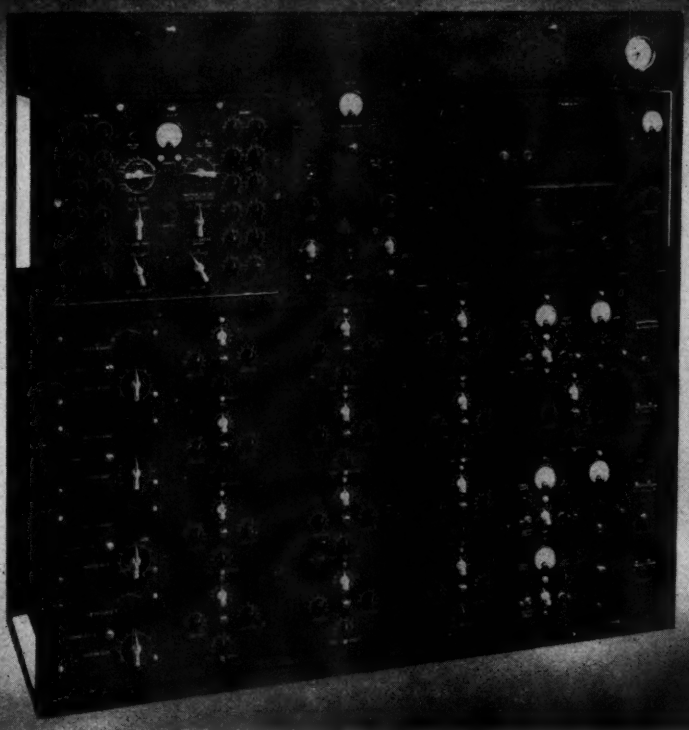

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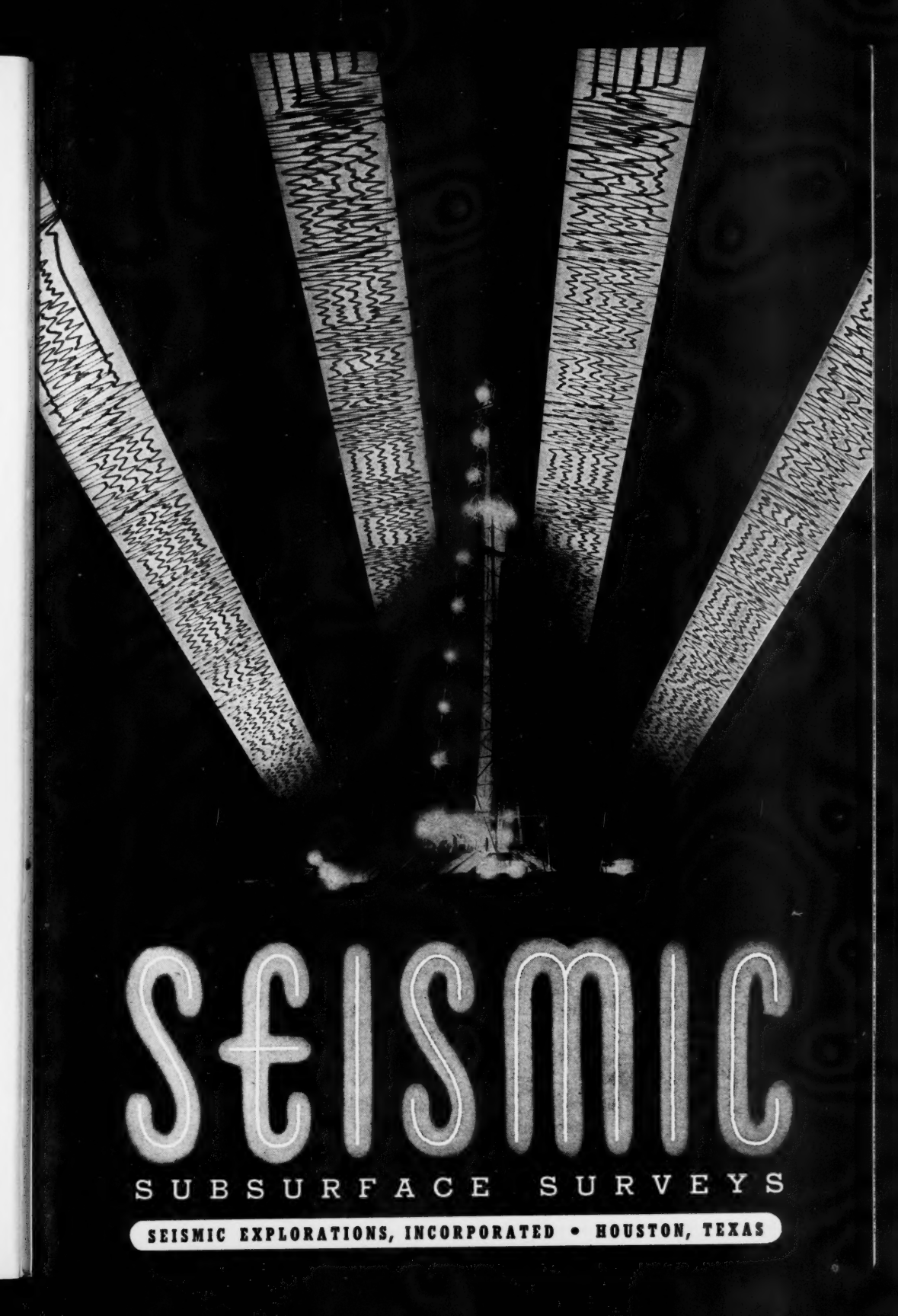
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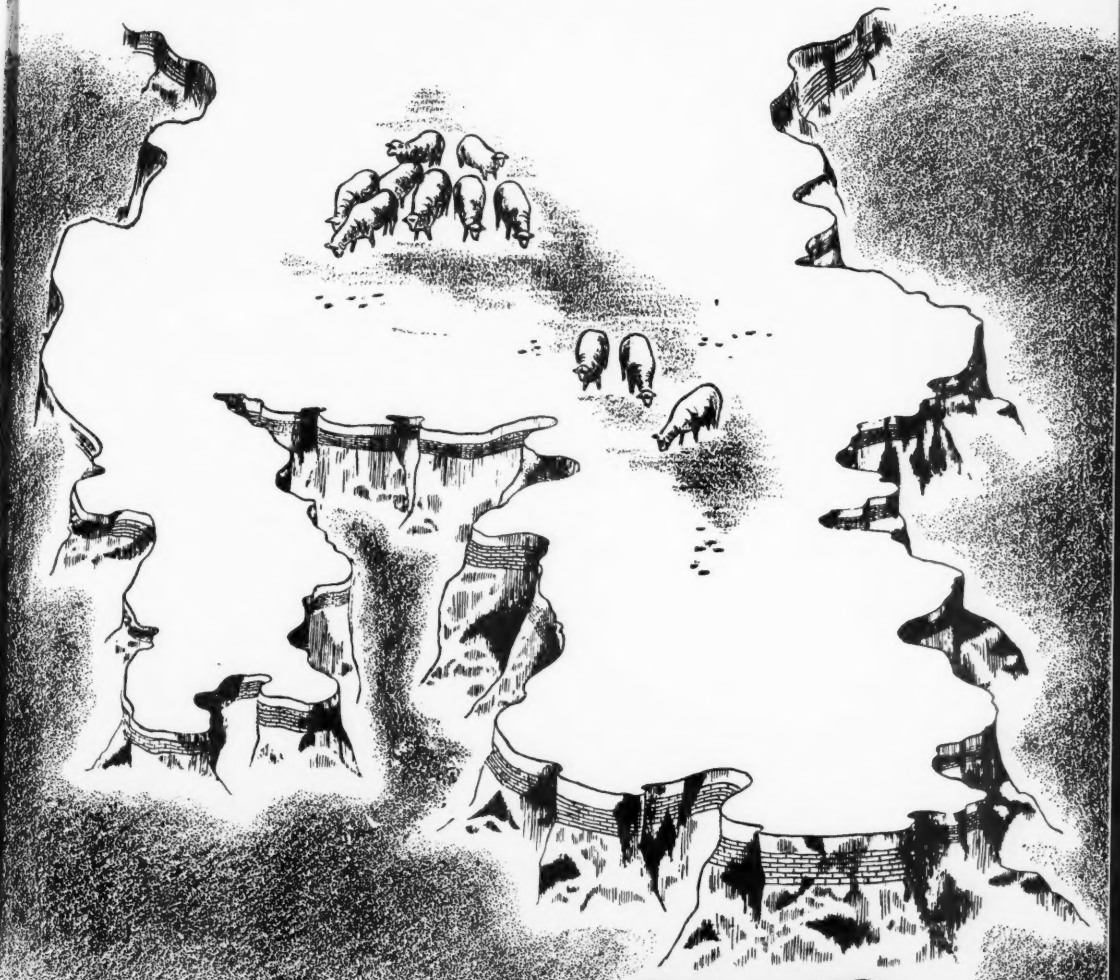

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